A POCKET HANDBOOK OF MINERALS

DESIGNED FOR USE IN THE FIELD OR CLASS-ROOM

WITH

LITTLE REFERENCE TO CHEMICAL TESTS

BY

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PREFACE.

OF works on mineralogy, there are a great number, but most of these are too cumbersome to be carried into the field and the descriptions are often so obscured with unimportant details as to make them of limited value except to specialists.

Of handbooks and tables on the subject, there are not a few, but these are mostly so condensed as to confuse rather than aid, are also often lacking in important details, and almost without exception they place the emphasis upon *chemical*, rather than physical distinctions, thus greatly limiting their value to one in the field.

This work is designed to occupy a middle ground. Although of pocket size, it aims to give *all* the details which may be needed to identify most of the minerals which mining men, students, or collectors are apt to encounter, and the emphasis is always placed upon characteristic *physical* features — little details which would ordinarily be overlooked by all but trained mineralogists, and which are often unknown to these if their training has been too closely confined to the chemical side of the science.

Nothing is herein included which may not be needed in the pursuit of the end for which the book was prepared, *i.e.*, the determination of minerals, and it is to be hoped that little has been omitted which might further that end.

That the book is usable, has been proven by the fact that scores of copies of the author's manuscript have been made by men in his classes and are now serving their purpose in the field. It is through these men, whose notes are now worn out or lost, and through many others, who

may have seen these copies, that the need for a book of this type has been made plain.

Whatever merit the book may possess will lie in the selection and arrangement of the facts presented, not in their originality. An effort has been made to offer a few *perfectly determinative tests*, rather than many details of doubtful importance.

All of these features are embodied in the course which has been given for many years by Prof. H. B. Patton in the Colorado School of Mines, and which has produced such thorough and practical results as to prove its excellence. The author is indebted to this course for his main ideas. He also desires to acknowledge indebtedness to Dana's "System of Mineralogy" and Moses and Parson's "Mineralogy, Crystallography and Blowpipe Analysis," as well as to other works, for much detailed information, and to the Foote Mineral Company, 107 North Nineteenth Street, Philadelphia, probably the best-known dealers in scientific minerals in this country, for several illustrations.

The work is not intended to be used as a manual of mineralogy but is planned to supplement lectures on the subject and to serve as a note-book on the same, thus insuring the possession of an accurate and complete set of notes. Abundant space is left for any additional matter which the owner may desire to add. It is believed, nevertheless, that the essential features are explained with sufficient care to make the book useful to collectors or mining men who have not had previous training in the subject.

Attention is invited to the following more or less original features:

1. The placing of the emphasis upon the most important characteristics by means of heavy face type. A mere glance at a page will often thus suffice to recall the appearance of a mineral, when a long description, or one in which

the important points were not thus emphasized, would fail to secure this result.

This feature is original with the author although it is used in a similar work by Mr. R. W. Richards, which did not appear until some time after the plan had been discussed with, and approved by, the publishers of this "Handbook of Minerals."

2. A systematic arrangement by paragraphs. Any feature can be at once found by looking for it in its proper place, and the whole description need not be perused to obtain the desired information.

The scheme used may be thus outlined:

Dana's Number. Name. Composition. Hardness.

Lustre.
Color.
Streak.
Cleavage or parting.
Tenacity and fracture.
Degree of translucency.
Specific gravity.
Miscellaneous (magnetism, taste, odor, dichroism, etc.).

B. B. (Before Blowpipe). Here are included simple chemical tests.

Methods or habits of occurrence with a description of the crystals if the species crystallizes.

Description of varieties.

A list of minerals resembling the species under discussion, and with which it should be compared.

A short statement of the uses of the mineral.

Any species will not contain matter under all of these heads unless all are important.

3. A page following each group, containing a statement of the group characteristics and illustrations of the minerals preceding. The former will be found a considerable aid to students.

4. The provision of plenty of space for additional notes.

5. The strong binding in a form which will fit the pocket.

6. The tables in the back — a new feature which, it is hoped, may occasionally prove helpful.

It is the author's desire to make subsequent editions as complete and accurate as possible, and he will always welcome corrections or suggestions.

Some knowledge of crystallography and blowpipe analysis will be found necessary for a complete understanding of the descriptions which follow.

The names of minerals and metals are capitalized for the sake of emphasis.

TABLE OF CONTENTS.

NATIVE ELEMENTS.

1. DIAMOND. C. **Hardness 10.**

Lustre. — **Adamantine.**

Color. — **Colorless, white**; frequently pale tints of yellow, red, blue, green, brown; sometimes black.

Streak. — None.

Cleavage. — Perfect octahedral.

Brittle.

Transparent to opaque.

B. B. — Unaltered.

Occurs crystallized in octahedrons or rounded octahedral forms and, rarely, in a cubical habit. Contact and penetration twins are common and the faces are frequently curved and striated.

The mineral also occurs granular to compact massive and in rounded forms.

Varieties.

BORT.

Opaque and dark colored; **in rounded forms** without cleavage. It is very tough.

CARBONADO.

Granular to compact-**massive** mineral without cleavage.

A very beautiful and valuable gem and the opaque material furnishes the best known abrasive substance.

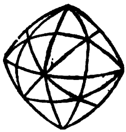

Fig. 1.
Rounded Crystal.

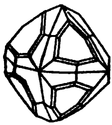

Fig. 2.

2. GRAPHITE. C. **Hardness 1-2.**

Lustre. — Metallic to dull.
Color. — **Dark gray to black.**
Streak. — Dark gray.
Cleavage. — Perfect basal.
Feels greasy and soils the fingers.
Cleavage laminae are flexible.
Sectile.
Opaque.

B. B. — Unaffected.

Occurs rarely in six-sided tabular crystals and commonly in imbedded scales and foliated-, granular-, or compact-massive. Usually found in Granites, Schists or Limestones; occasionally in Traps.

Varieties.

There are several varieties of little importance which are really intermediate between Graphite and Anthracite (p. 270) in character and composition.

Compare with Molybdenite (p. 22) and Micaceous Hematite (p. 83).

Is used in the manufacture of lubricant, infusible crucibles, etc., and " lead " pencils.

3. SULPHUR. S. **Hardness 1.5-2.5.**

Lustre. — **Resinous.**

Color. — **Various shades of yellow,** orange, brown, and gray.

Streak. — White or yellowish.

Fracture. — Conchoidal to uneven.

Very brittle.

Transparent to translucent.

B. B. **or in a match flame — Melts and gives off So_2 fumes.**

Occurs in **distinct orthorhombic crystals** and more or less porous massive. Also stalactitic, incrusting and powdery.

The habit of the crystals is often apparently sphenoidal.

Brown Sulphur contains Selenium.

Compare with Orpiment (p. 19).

Is used in enormous quantities in various arts and trades.

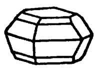

FIG. 3.

TELLURIUM GROUP.

7. TELLURIUM. Te. **Hardness 2-2.5.**

Lustre. — **Metallic.**
Color. — **Tin white.**
Streak. — Tin white.
Cleavage. — **Perfect, parallel to the hexagonal prism.**
Brittle.
S. G. — 6 +.

B. B. — On charcoal fuses easily and **volatilizes completely, giving a heavy, white coating and a green flame.**

Occurs fine-grained or cleavable-massive and, rarely, in minute hexagonal prisms.

Compare with Sylvanite (p. 50).

Of little or no value but is frequently associated with Gold and Silver.

8. ARSENIC. As. **Hardness 3.5.**

Lustre. — Metallic.
Color. — Tin white, **tarnishing to black.**
Streak. — Tin white.
Cleavage. — Perfect basal. Granular fracture. Brittle.

B. B. — **Volatilizes readily and entirely without fusing and gives a garlic-like odor,** yielding the characteristic As sublimate on charcoal.

Occurs usually in granular, mammillary or spherical masses which often **separate in concentric layers.**

Compare with Antimony (p. 7), Allemontite (p. 6) and Galenite (p. 26).

Arsenic or its compounds is used in alloys, in medicine, as a poison, and in many arts and trades.

9. ALLEMONTITE. SbAs. Hardness 3.5.

Lustre. — Metallic, sometimes very brilliant.
Color. — Tin white, **tarnishing to gray or brownish black.**
Streak. — Tin white.
Fracture. — Granular.

B. B. — **Fuses easily and volatilizes with As and Sb reactions.**

Occurs usually in finely granular masses. Sometimes exhibits a curved lamellar structure.

Compare with Arsenic (p. 5), Antimony (p. 7) and Galenite (p. 26).

10. ANTIMONY. Sb. Hardness 3–3.5.

Lustre. — Metallic.
Color. — Tin white. **It does not tarnish.**
Streak. — Tin white.
Cleavage. — Perfect basal and poor to good rhombohedral.
Very brittle.

B. B. — **Fuses and then volatilizes,** yielding the characteristic Sb sublimate on charcoal.

Occurs in finely to coarsely granular masses and, rarely, lamellar or radiated.

Very infrequently found in rhombohedral crystals, either simple or complexly twinned.

Compare with Arsenic (p. 5), Allemontite (p. 6) and Galenite (p. 26).

TELLURIUM GROUP.

Members. — Tellurium, Arsenic, Allemontite, Antimony.

Composition. — Semi-metals.

Crystallization. — Rhombohedral hemihedral hexagonal.

Additional. — All are tin white in color when freshly broken, all have a tin-white streak and a metallic lustre, and all volatilize B. B.

GOLD GROUP.

13. GOLD. Au. Hardness 2.5–3.

Lustre. — Metallic.

Color. — **Golden yellow** to nearly silver white. **Does not tarnish.**

Streak. — **Yellow** to nearly white.

Fracture. — Hackly.

Very malleable and ductile.

S. G. — **19.3.** Impurities may lower the S. G. to as low as 15.6.

B. B. — On charcoal fuses to a bright yellow button. Insoluble in any single acid.

Occurs in nuggets, grains and scales and in small octahedral or dodecahedral crystals which are usually badly distorted and are very apt to be united in wire-like, net-like or dendritic shapes.

Varieties.

The varieties are based upon and named after the impurity which may be present.
The common impurities are Ag, Cu, Bi, Rh and Pd.

Gold is the only yellow, malleable mineral.

The economic value and uses of Gold are well known.

See Fig. 4.

14. SILVER. Ag. Hardness 2.5–3.

Lustre. — Metallic.

Color. — **White. Easily tarnishes to brownish gray or black and sometimes yellow, then closely resembling Gold.**

Streak. — White.

Fracture. — Hackly.

Malleable and ductile.

S. G. — **10.5.** Impurities may make this as low as 10.1 or as high as 11.1.

B. B. — On charcoal fuses to a white globule. Soluble in nitric or sulphuric acids and is precipitated from these in a white, curdy form by hydrochloric acid.
This precipitate turns purple when exposed to the sun.

Occurs in masses, plates, scales and in isometric crystals which are commonly distorted and elongated to acicular forms and united in arborescent groupings.

When tarnished, Silver may resemble Gold (p. 9) or Copper (p. 11). Compare with these.

The economic value and uses of Silver are well known.

See Fig. 5.

15. COPPER. Cu. Hardness 2.5–3.

Lustre. — Metallic.

Color. — **Copper red. Easily tarnishes bronze-green to black.**

Streak. — Copper red.

Fracture. — Hackly.

Very malleable and ductile.

S. G. — **8.9.**

B. B. — On charcoal fuses to a copper-red globule which is sometimes covered with a coating of black oxide.

Occurs in sheets, masses weighing many tons down to very small disseminated particles, and in wire-like or arborescent aggregates of much distorted isometric crystals.

Compare with Silver (p. 10), Niccolite (p. 36) and Bornite (p. 39).

The economic value and uses of Copper are well known.

See Fig. 6.

16. MERCURY. Hg. Hardness **Liquid.**

Lustre. — **Very brilliant metallic.**
Color. — Tin white.
Streak. — Tin white, when solid.
Cleavage. — Perfect cubic, when solid.
S. G. — 13.6.

B. B. — Completely volatile.

Occurs in small, fluid globules in cavities in the gangue-rock.

Mercury is the only mineral of metallic lustre that is liquid at ordinary temperatures.
The mineral becomes solid at − 40° C., crystallizing in octahedrons.

Mercury is used in considerable quantities in some of the processes by which Gold and Silver are extracted from "free-milling" ores. It is also in demand for the manufacture of vermilion paint, in medicine, and in many arts and trades.

GOLD GROUP.

Members. — Gold, Silver, Copper and Mercury.

Composition. — Heavy metals.

Crystallization. — Holohedral isometric.

Additional. — All are very heavy, have a metallic lustre, are 2.5 to 3 in hardness and are malleable (Mercury must, of course, be solid to show this).

FIG. 4. — Gold Nugget, California.

FIG. 5. — Leaf Silver, Leadville, Colorado.

FIG. 6.—Native Copper, Northern Michigan.

PLATINUM-IRON GROUP.

20. PLATINUM. Pt. **Hardness 4-4.5.**

Lustre. — Metallic.
Color. — **Light steel gray.**
Streak. — Steel gray.
Fracture. — Hackly.
Malleable and ductile.
S. G. — **14-19** as found in nature; 22 when chemically pure.

B. B. — Infusible. Soluble only in hot aqua-regia.

Occurs as nuggets, grains, and scales, usually in alluvial deposits. Found very rarely in cubical, isometric crystals.

Varieties.

Ordinary.

Non-magnetic or only slightly magnetic.

Magnetic.

Usually contains considerable quantities of Iron or Nickel, which increases the hardness to as much as 6 and decreases the S. G. to as low as 14.

Compare with Silver (p. 10).

Platinum is now being used to a considerable extent in jewelry and for laboratory apparatus.

25. IRON. Fe. Hardness 4–5.

Lustre. Metallic.
Color. — Steel-gray to black.
Streak — Gray.
Fracture. — Hackly.
Malleable.
S. G. — **7.3–7.8.**
Very magnetic.

B. B. — Infusible. Soluble in acids.

Occurs very rarely native as it oxidizes very readily.
It is usually found in masses or as disseminated particles; rarely in cubo-octahedral crystals.

Varieties.

Terrestrial.

Originating in the earth.

Meteoric.

Most meteorites contain Iron and many are composed almost entirely of this metal. Nickel, varying in amount from about five to ten per-cent is present in all iron meteorites — siderites or holosiderites.

Compare with Silver (p. 10) and Platinum (p. 15).

Metallic Iron is too rare to be of economic importance.

PLATINUM-IRON GROUP.

Members. — Platinum, Iron.

Composition. — Metals.

Crystallization. — Holohedral isometric.

Additional. — Both have a hardness between 4 and 5, a metallic lustre, and are malleable.

SULPHIDES, ETC.,

OF THE

SEMI-METALS AND MOLYBDENUM.

26. REALGAR. As_2S_2. Hardness 1.5–2.

Lustre. — Resinous.
Color. — **Orange-red or orange-yellow.**
Streak. — **Orange red.**
Cleavage. — Fair pinacoidal.
Slightly sectile.
Translucent to transparent.

B. B. — On charcoal fuses easily. Gives S and As reactions.

Occurs usually in translucent, granular masses or compact; also in transparent, monoclinic crystals and as an incrustation.

It is usually associated with Orpiment (p. 19) to which it alters.

Compare with Orpiment (p. 19), Ruby Silvers (pp. 55–56), Cinnabar (p. 33) and Cuprite (p. 79).

Seldom occurs in sufficiently large amounts or pure enough to be valuable.

STIBNITE GROUP.

27. ORPIMENT. As_2S_3. Hardness 1.5–2.

Lustre. — Resinous.
Color. — **Lemon yellow.**
Streak. — **Lemon yellow.**
Cleavage. — **Perfect pinacoidal.** Cleavage laminae are flexible and often striated.
Sectile.
Translucent.

B. B. — On charcoal fuses easily. Gives S and As reactions.

Occurs in thin scales, foliated or columnar massive, and finely granular like the yolk of a hard boiled egg.
Rarely found as imperfect orthorhombic crystals.
Usually associated with Realgar (p. 18).

Compare with Sulphur (p. 3).

Seldom occurs in sufficiently large amounts or pure enough to be valuable.

28. STIBNITE. Sb_2S_3. Hardness 2.

Lustre. — Bright metallic.
Color. — Lead gray, tarnishing iridescent or black.
Streak. — Lead gray.
Cleavage. — **Perfect pinacoidal, yielding blade-like strips which are usually striated perpendicular to the long direction.**
Very brittle.

B. B. — On charcoal fuses very easily. Gives Sb and S reactions.

Occurs in imperfectly crystallized **masses with a columnar or bladed structure** or in acutely terminated, prismatic orthorhombic crystals which are usually vertically striated and are often bent.

Compare with Galenite (p. 26) and Jamesonite (p. 53).

A valuable mineral since it is the chief source of Antimony and its artificial salts. Sometimes carries Gold and Silver.

Antimony is chiefly used in the manufacture of safety matches, fireworks, percussion caps, type, and other alloys.

See Fig. 8.

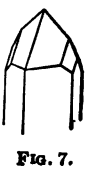

Fig. 7.

STIBNITE GROUP.

Members. — Orpiment, Stibnite.

Composition. — Sulphides of semi-metals.

Crystallization. — Orthorhombic.

Additional. — Both are about 2 in hardness and have perfect pinacoidal cleavage.

FIG. 8. — Stibnite, Hungary.

34. MOLYBDENITE. MoS_2. Hardness 1–1.5.

Lustre. — Metallic.

Color. — Bluish or brownish lead gray.

Streak. — **Greenish on glazed porcelain.**

Cleavage.— Perfect basal. **Cleavage laminae very flexible but not elastic.**

Sectile.

May feel slightly greasy but this is not so noticeable as with Graphite.

B. B. — Infusible. Mo reactions on charcoal.

Occurs in granular or foliated masses or **scales** scattered through or embedded in many crystalline rocks; also in tabular hexagonal crystals.

Compare with Graphite (p. 2).

Molybdenite is the chief source of Molybdenum which is used to color pottery blue, in the manufacture of paint and dyes and as ammonium molybdate, a valuable reagent in chemistry.

See Fig. 10.

SULPHIDES, ETC., OF THE METALS.

MONOSULPHIDES.

GALENITE GROUP.

42. ARGENTITE. Ag_2S. Hardness 2–2.5.

Lustre. — Metallic.
Color. — Lead gray to black.
Streak. — Lead gray; shining.
Very sectile when pure. Uneven fracture.
S. G. — 7.

B. B. — Swells and fuses, yielding a button of Silver and Sulphur fumes. Soluble in HNO_3.

Occurs massive, in grains, earthy, and encrusting; also in arborescent groupings of isometric crystals.
Frequently associated with Galenite and Sphalerite.

Compare with Chalcocite (p. 29), Hessite (p. 24) and Petzite (p. 25).

A valuable ore of Silver.

43. HESSITE. Ag_2Te. Hardness 2.5–3.

Lustre. — Metallic.
Color. — Between lead and steel gray.
Streak. — Black.
Slightly sectile. Uneven fracture.
S. G. — 8.5.

B. B. — **On charcoal fuses to a black globule, dotted with Ag. If this be powdered and dropped into strong, boiling H_2SO_4, the acid will be colored an intense purple.**

Occurs compact, fine (usually) granular, and in small, often distorted, isometric crystals.

Compare with Chalcocite (p. 29), Argentite (p. 23) and Petzite (p. 25).

A rare but valuable ore of Gold and Silver, the former often replacing the latter to a considerable extent.

44. PETZITE. $(Ag,Au)_2Te$. Hardness 2.5–3.

Lustre. — Metallic.
Color. — Steel gray to black. Often tarnishes.
Streak. — Black.
Slightly sectile to brittle. Uneven fracture.
S. G. — 8.7–9.

B. B. — Like Hessite (p. 24) except that it yields a globule containing both Au and Ag.

Occurs fine granular to compact massive. Crystals are unknown and it is believed that the mineral may be orthorhombic and belong to the Chalcocite Group.

Compare with Chalcocite (p. 29), Argentite (p. 23) and Hessite (p. 24).

A rare but valuable ore of Gold and Silver.

45. GALENITE. PbS. Hardness 3–.

Lustre. — Metallic.
Color. — Lead gray. Tarnishes to black.
Streak. — Lead gray.
Cleavage. — **Perfect cubic.**
Brittle.
S. G. — 7.5.

B. B. — Usually decrepitates and fuses easily yielding lead oxide sublimates and SO_2 fumes.

Occurs massive cleavable, coarse to fine granular, rarely fibrous, and in isometric (usually cubo-octahedral) crystals; sometimes in skeleton crystals or reticulated.

Varieties.

Argentiferous.

The mineral, especially the fine grained variety called **STEEL GALENA**, may contain so much Silver as to make it a valuable Silver ore. Gold and many other elements are also often present.

Compare with Antimony (p. 7), Allemontite (p. 6), Stibnite (p. 20) and Jamesonite (p. 53).

The principal ore of Lead and often very valuable because of its Gold and Silver content.

See Fig. 11.

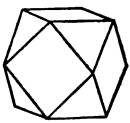

Fig. 9.

46. ALTAITE. PbTe. Hardness 3.

Lustre. — Metallic.
Color. — Tin white or yellowish. **Tarnishes bronze-yellow.**
Streak. — Grayish black.
Cleavage. — Poor cubic. Slightly sectile.

B. B. — On charcoal fuses easily with characteristic flame and sublimates and is entirely volatile except for a trace of Ag which may be present.

Occurs usually massive in rather small pieces disseminated through the gangue; rarely in cubical crystals.

The tarnish on a mineral of this character is distinctive.

GALENITE GROUP.

Members. — Argentite, Hessite, Petzite, Galenite, Altaite.

Composition. — Monosulphides or tellurides of the heavy metals.

Crystallization. — Holohedral isometric.

Additional. — All are between 2 and 3 in hardness and fuse easily.

FIG. 10. — Molybdenite, Quebec, Canada.

FIG. 11. — Galenite, Joplin, Missouri.

54. CHALCOCITE. Cu_2S. Hardness 2.5–3.

Lustre. — Metallic or dull when tarnished.
Color. — **Dark** lead-gray. **Frequently tarnished dull black or green.**
Streak. — Lead-gray.
When pure, cuts easily, leaving a polished surface.
No cleavage. Conchoidal fracture when compact.

B. B. — On charcoal fuses easily and boils with intumescence.

Occurs usually compact massive, sometimes finely granular; also in orthorhombic crystals which are sometimes twinned in star-like forms.

Compare with Tetrahedrite (p. 57), Tennantite (p. 57), Argentite (p. 23), Hessite (p. 24) and Petzite (p. 25).

A valuable ore of Copper.

SPHALERITE GROUP.

58. SPHALERITE. ZnS. Hardness 3.5–4.

Lustre. — **Resinous** to sub-metallic.

Color. — **Yellow, brown,** black, red, green, white.

Streak. — White, yellow, brown. **Always lighter in color than the mineral itself.**

Cleavage.— **Perfect dodecahedral.**

Brittle.

Opaque to transparent.

B. B. — On charcoal yields sublimate of zinc oxide. Fuses with difficulty.

Occurs compact, fine-grained to cleavable massive, sometimes fibrous, stalactitic or botryoidal, and in perfect to indistinct inclined hemihedral isometric crystals which are often twinned.

Associated with Galenite and Silver minerals.

Hardness combined with streak should be sufficient to distinguish from all similar minerals.

It is an important ore of Zinc and an impure variety yields most of the Cadmium of commerce.

See Fig. 14.

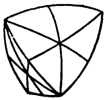

FIG. 12.
Rounded Crystal.

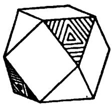

FIG. 13.

63. ALABANDITE. MnS. Hardness 3.5–4.

Lustre. — Submetallic.
Color. — Iron-black.
Streak. — **Dark green.**
Cleavage. — Good cubic.
Brittle.

B. B. — Gives a Mn bead after thorough roasting on charcoal. Fuses.
Soluble in dilute HCl, giving off H_2S.

Occurs usually granular massive, and rarely in inclined hemihedral isometric crystals.

Found as a vein mineral with other metallic sulphides.

The streak should be sufficient to distinguish it from all similar minerals.

Not economically important but may, by alteration, form other Manganese minerals.

SPHALERITE GROUP.

Members. — Sphalerite, Alabandite.

Composition. — Monosulphides of metals.

Crystallization. — Inclined hemihedral isometric.

Additional. — The hardness of both is 3.5 to 4.

Fig. 14. — Botryoidal Sphalerite, Aspen, Colorado.

CINNABAR-MILLERITE GROUP.

66. CINNABAR. HgS. Hardness 2–2.5.

Lustre. — Adamantine to earthy.

Color. — **Cochineal red, scarlet,** reddish brown, black (due to organic impurities).

Streak. — **Scarlet.**

Cleavage. — Perfect hexagonal prismatic, but seldom recognizable.

Brittle.

Transparent to opaque.

S. G. — **8-8.2.**

B. B. — Wholly volatile, yielding poisonous fumes. Gives Hg and S reactions.
If the powder is moistened with HCl and rubbed on a bright copper coin, the latter will be coated with Mercury.

Occurs in granular or earthy masses, as a brilliant scarlet powder, as a crystalline or earthy incrustation and, rarely, as tabular or prismatic trapezohedral tetartohedral hexagonal crystals, usually small and transparent.

Compare with Cuprite (p. 79), Hematite (p. 83), Rutile (p. 95), Realgar (p. 18), Proustite (p. 56) and Crocoite (p. 254).

The only important ore of Mercury.

67. COVELLITE. CuS. Hardness 2.5.

Lustre. — Submetallic, resinous or dull.
Color. — **Indigo blue** or darker.
Streak. — Black (shining).
Cleavage. — **Perfect basal.** Thin leaves are flexible.
Opaque.
Turns purple when moistened with water.

B. B. — Emits odor of S and burns with a blue flame, on charcoal, fusing to a globule.

Occurs massive, with or without a crystalline surface, and either cleavable or granular, in platy aggregates and, rarely, as tabular rhombohedral hemihedral hexagonal crystals.

The change of color when moistened is distinctive on a mineral of this character.

An ore of Copper.

70. MILLERITE. NiS. **Hardness 3-3.5.**

Lustre. — Metallic.

Color. — **Brass-yellow** to bronze-yellow. Sometimes shows a gray, iridescent tarnish.

Streak. — Greenish black.

Brittle, but the hair-like crystals are elastic.

B. B. — Fuses on charcoal to a brittle, magnetic globule.

Occurs in semi-botryoidal **crusts with a radiating structure** and in hair- or needle-like hexagonal crystals in either delicate, radiating groups or complexly interwoven.

Compare with Marcasite (p. 46).

It is a valuable ore of Nickel. It is probable that the Nickel in Pyrrhotite is present as Millerite.

71. NICCOLITE. NiAs. Hardness 5–5.5.

Lustre. — Metallic.
Color. — **Light copper-red with a dark tarnish.**
Streak. — Light brownish black.
Very fine grained, smooth structure.
Brittle.

B. B. — On charcoal fuses easily, leaving a magnetic residue.

Occurs usually massive; rarely reniform with a columnar structure, arborescent, or in small, poorly formed hexagonal crystals.

Compare with Copper (p. 11), Pyrrhotite (p. 37) and Bornite (p. 39).

An important ore of Nickel.

74. PYRRHOTITE. Fe_nS_{n+1}. Hardness 3.5–4.5.

Lustre. — Metallic.
Color. — **Brownish or bronze-yellow.** Tarnishes.
Streak. — Grayish Black.
Uneven fracture. Brittle.
Magnetic.

B. B. — On charcoal fuses to a black, magnetic mass.

Occurs massive, in scattered grains and, rarely, in small tabular hexagonal crystals.

Varieties.

Nickeliferous.

Pyrrhotite frequently contains as much as 5% Nickel.

Differs from all other minerals which it may resemble in being magnetic. The powder can always be picked up by a magnet and the mineral will sometimes attract the magnet, like Magnetite.

The nickeliferous variety is one of the principal ores of Nickel.

(Note: The "n" in the formula is usually 11, but it is sometimes 5, 7 and 16.)

CINNABAR-MILLERITE GROUP.

Members. — Cinnabar, Covellite, Millerite, Niccolite, Pyrrhotite.

Composition. — Monosulphides and arsenides of metals.

Crystallization. — Rhombohedral hemihedral, trapezohedral tetartohedral, and holohedral hexagonal.

The group is not well characterized.

INTERMEDIATE SULPHIDES.

78. BORNITE. Cu_3FeS_3. Hardness 3-3.5.

Lustre. — Metallic.
Color. — **Dark reddish brown — "pinchbeck" brown — on a fresh fracture, speedily tarnishing blue, purple or iridescent.**
Streak. — Grayish black.
Uneven to conchoidal fracture. Brittle.

B. B. — Fuses on charcoal to a brittle, black, magnetic globule.

Occurs compact to granular massive and, rarely, in small isometric crystals.
Is often associated with, or intimately mixed with Chalcocite (p. 29).

Compare with Copper (p. 11), Niccolite (p. 36) and Pyrrhotite (p. 37).

A valuable ore of Copper.

83. CHALCOPYRITE. $CuFeS_2$. Hardness 3.5–4.

Lustre. — Metallic.
Color. — **Bright brass yellow. Iridescent tarnish.**
Streak. — **Black.**
Brittle. Uneven fracture.

B. B. — Fuses with scintillation on charcoal to a brittle, magnetic globule.

Occurs usually massive or scattered through the gangue in small particles; also in sphenoidal hemihedral tetragonal crystals which closely resemble isometric forms.

Compare with Gold (p. 9) and Pyrite (p. 42); also Bornite (p. 39) when tarnished.

This is one of the most important ores of Copper and frequently carries considerable amounts of Gold and Silver.

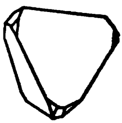

FIG. 15.

84. STANNITE. $Cu_2S.FeS.SnS_2$. Hardness 4.

Lustre. — Metallic.

Color. — **Greenish gray.** The presence of Chalcopyrite often gives a yellowish tinge.

Streak. — Black.

Brittle. Uneven fracture.

B. B. — On charcoal fuses in the reducing flame and in **the oxidizing flame yields a coating of white tin oxide.**

Occurs massive or granular, never crystallized, and is frequently **associated with Chalcopyrite** (p. 40).

Compare with Tetrahedrite (p. 57).

Too rare to be considered an ore of Tin.

DISULPHIDES, ETC.

PYRITE GROUP.

85. PYRITE. FeS_2. Hardness 6–6.5.

Lustre. — Metallic.

Color. — **Pale to full brass-yellow.** Tarnishes iridescent to brown.

Streak. — Greenish black.

Cleavage. — **Usually none** apparent. Otherwise, poor to good cubic.

Brittle. Fracture conchoidal to uneven.

B. B. — On charcoal, burns with a blue flame, yielding SO_2 fumes and leaving a magnetic residue.

Occurs in well formed and frequently very complex **parallel hemihedral isometric crystals**; also massive and in any shape, as botryoidal, stalactitic, reniform or globular. Sometimes finely granular.

Compare with Gold (p. 9), Pyrrhotite (p. 37), Chalcopyrite (p. 40) and Marcasite (p. 46).

Enormous quantities of Pyrite are used in the manufacture of sulphuric acid, and large amounts contain sufficient Copper, Gold or Silver to constitute an ore of these metals.

See Figs. 17 and 18.

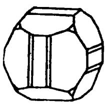

Fig. 16.

87. SMALTITE. $(CoNi)As_2$. Hardness 5.5–6.

88. CHLOANTHITE. $(NiCo)As_2$. Hardness 5.5–6.

Lustre. — Metallic.

Color. — Tin white to steel gray **with a tendency towards a pinkish tint.** Tarnishes gray or iridescent.

Streak. — Grayish black.

Cleavage. — None to **fair octohedral.**

B. B. — Fuses on charcoal to a globule, yielding an arsenical odor.
Yields a sublimate of metallic Arsenic in the closed tube.

Occurs usually granular massive or in parallel hemihedral isometric crystals like Pyrite (p. 42); rarely in imitative shapes.

Compare with Cobaltite (p. 44), Lollingite (p. 47) and Arsenopyrite (p. 48).

These form the chief ores of Cobalt, which is principally used in the manufacture of pigments.

89. COBALTITE. CoAsS. Hardness 5.5.

Lustre. — Metallic.

Color. — Tin-white to steel-gray, **usually with a pinkish or violet tint.**

Streak. — Grayish black.

Cleavage. — **Good cubical.**

B. B. — On charcoal, fuses to a magnetic globule, giving As and S fumes. **Unaltered in the closed tube.**

Occurs commonly granular to compact massive or in parallel hemihedral isometric crystals like Pyrite (p. 42).

Compare with Smaltite (p. 43), Lollingite (p. 47) and Arsenopyrite (p. 48).

A valuable ore of Cobalt.

PYRITE GROUP.

Members. — Pyrite, Smaltite, Chloanthite, Cobaltite.

Composition. — Disulphides and diarsenides of metals.

Crystallization. — Parallel hemihedral isometric.

Additional. — All are light in color, have a metallic lustre, and are about 6 in hardness.

FIG. 17.—Pyrite in Rhodochrosite, Alicante, Colorado.

FIG. 18.—Pyrite, Elba.

MARCASITE GROUP.

96. MARCASITE. FeS_2. Hardness 6–6.5.

Lustre. — Metallic.
Color. — Pale brass-yellow. **Paler than Pyrite.**
Streak. — Grayish or brownish black.
Cleavage. — **Usually none** apparent; sometimes poor prismatic at angle of 105°.
Brittle. Uneven fracture.

B. B. — On charcoal, burns with a blue flame, yielding SO_2 fumes and leaving a magnetic residue.

Occurs in **orthorhombic crystals**, usually tabular or twinned complexly and united in crest- or spear-like forms; also stalactitic, with a radiating structure and drusy surface, globular, reniform, or imitative.
More apt to show imitative shapes than Pyrite.

Compare with Gold (p. 9), Pyrrhotite (p. 37), Chalcopyrite (p. 40) and Pyrite (p. 42).

The uses are the same as for Pyrite (p. 42), q. v.
It is more apt to decompose than Pyrite and is thus even less desirable than that mineral in building stone.

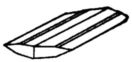

Fig. 19.

97. LÖLLINGITE. $FeAs_2$. Hardness 5–5.5.

Lustre. — Metallic.
Color. — **Silver-white** to steel gray.
Streak. — Grayish black.
Cleavage. — None, or fair basal.
Brittle. Uneven fracture.

B. B. — On charcoal, fuses to a magnetic globule with reactions for As. Yields metallic As sublimate in the closed tube.

Occurs usually as grains disseminated through a **gangue which is frequently Hornblende** (p. 152); also massive and, rarely, in orthorhombic crystals closely resembling those of Arsenopyrite (p. 48).

Compare with Arsenopyrite (p. 48).

Has no value.

98. ARSENOPYRITE. FeAsS. Hardness 5.5–6.

Lustre. — Metallic.
Color. — Silver-white to grayish white.
Streak. — Grayish black.
Cleavage. — **Good prismatic at angle of about 112°.**

B. B. — On charcoal, fuses to a magnetic globule with reactions for As. In the closed tube, yields a sublimate of As_2S_3, orange when hot and yellow, cold.
When struck with a hammer, emits sparks and the odor of As.

Occurs cleavable columnar, granular or compact massive, as disseminated grains, and as simple orthorhombic crystals.

Compare with Smaltite (p. 43), Cobaltite (p. 44) and Lollingite (p. 47).

Most of the Arsenic of commerce is obtained from this mineral, which also may carry enough Gold or Cobalt to make it an ore of those metals.

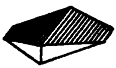

FIG. 20.

MARCASITE GROUP.

Members. — Marcasite, Lollingite, Arsenopyrite.

Composition. — Disulphides and diarsenides of metals.

Crystallization. — Orthorhombic.

Additional. — All are light in color, have a metallic lustre, and are hard minerals — between 5 and 6 1/2.

SYLVANITE GROUP.

104. SYLVANITE. (Au,Ag)Te_2. **Hardness 1.5-2.**

Lustre. — Metallic, brilliant.
Color. — Silver-white, inclining to yellow, to steel-gray in the Graphic Tellurium.
Streak. — **Like the color.**
Cleavage. — **Good pinacoidal.**
Brittle.

B. B. — On charcoal, fuses easily with a green flame to a gray globule, giving a dense, white sublimate, which burns off with a green flame. After long blowing, gives a yellow, malleable button.
Gives Te reaction described under Hessite (p. 24).

Occurs in bladed or prismatic indistinct monoclinic crystals, and granular.

Variety.

GRAPHIC TELLURIUM.

Flat crystals, grouped together so as to resemble Hebrew characters.

Compare with Pyrite (p. 42) and Calaverite (p. 51).

A very valuable ore of Gold and Silver.

105a. CALAVERITE. $AuTe_2$. **Hardness 2.5.**

Lustre. — Brilliant metallic.
Color. — **Pale brass-yellow** to almost white.
Streak. — **Yellowish gray.**
Cleavage. — **None.**
Uneven to sub-conchoidal fracture. Brittle.

B. B. — Like Sylvanite (p. 50), q. v.

Occurs massive, non-crystalline.

Compare with Pyrite (p. 42) and Sylvanite (p. 50).

Calaverite always contains a little Silver, as well as Gold, and is a very valuable ore of both those metals.

SYLVANITE GROUP.

Members. — Sylvanite, Calaverite.

Composition. — Tellurides of Gold or of Gold and Silver.

Crystallization. — Sylvanite is monoclinic but Calaverite does not crystallize.

Additional. — Both are light colored, have a brilliant metallic lustre, are about 2 in hardness, and act very similarly B. B.

SULPHO-SALTS.

SULPHARSENITES AND SULPHANTIMONITES.

130. JAMESONITE. $Pb_2Sb_2S_5$. Hardness 2–3.

Lustre. — Metallic.
Color. — Steel-gray to lead-gray.
Streak. — Grayish black.
Cleavage. — **Perfect pinacoidal.**
Brittle.

B. B. — **Decrepitates,** fusing very easily and rapidly volatilizing, yielding the characteristic Pb and Sb sublimates.

Occurs in bladed, parallel or divergent aggregates, frequently **striated parallel to the direction of elongation;** also fibrous to compact massive, as needle-like crystals, and in hair- or cobweb-like forms.

Is usually associated with Quartz and is **frequently coated with lead antimonate as a yellow powder.**

Compare with Stibnite (p. 20) and Galenite (p. 26).

Some varieties contain enough Silver to make them valuable.

136. BOURNONITE. $3\left\{\begin{matrix}Pb\\Cu_2\end{matrix}\right\}S.Sb_2S_3$. **Hardness 2.5-3.**

Lustre. — Metallic, brilliant.
Color. — Steel-gray to iron-black.
Streak. — Like color.
Cleavage. — None or, rarely, poor pinacoidal.
Rather brittle. Fracture, subconchoidal to uneven.

B. B. — On charcoal, fuses easily and gives Sb and Pb sublimates.

Occurs fine-grained massive and in **thick, tabular, orthorhombic crystals** with the prism faces often striated.

Compare with Galenite (p. 26), Chalcocite (p. 29) and Tetrahedrite (p. 57).

Too rare to be valuable.

144. PYRARGYRITE. Ag_3SbS_3. Hardness 2.5.

Lustre. — Adamantine to metallic.

Color. — **Black, but red by transmitted light**; sometimes reddish gray.

Streak. — **Purplish red.**

Brittle. Uneven to conchoidal fracture.

B. B. — Fuses easily with spurting, on charcoal, yielding a dense Sb sublimate and finally giving a globule of malleable Ag.

Occurs compact massive, disseminated in the form of flakes or films, and in hemimorphic, rhombohedral hemihedral hexagonal crystals. Usually associated with other Silver minerals.

Compare with Realgar (p. 18), Cinnabar (p. 33), Proustite (p. 56), Hematite (p. 83) and Cuprite (p. 79).

An important ore of Silver.

145. PROUSTITE. Ag_3AsS_3. Hardness 2–2.5.

Lustre. — Brilliant adamantine.
Color. — **Scarlet vermilion.**
Streak. — **Scarlet.**
Brittle. Uneven to conchoidal fracture.

B. B. — On charcoal, fuses easily, giving odors of As and S, yields As sublimate, and finally gives a globule of malleable Ag.

Occurs compact massive, disseminated as grains through the gangue, encrusting, and in hemimorphic, rhombohedral hemihedral hexagonal crystals. Usually associated with other Silver minerals.

Compare with Realgar (p. 18), Cinnabar (p. 33), Pyrargyrite (p. 55), Hematite (p. 83) and Cuprite (p. 79).

A valuable ore of Silver.

148. TETRAHEDRITE. $Cu_8Sb_2S_7$. Hardness 3–4.5.

149. TENNANTITE. $Cu_8As_2S_7$. Hardness 3–4.5.

Lustre. — Metallic.

Color. — **Steel-gray** to iron-black. Tennantite is apt to be light and may be brownish or reddish.

Streak. **Gray, brown or reddish,** the last two being more characteristic of Tennantite than of Tetrahedrite.

No cleavage. Uneven fracture. Brittle.

B. B. — On charcoal, fuses, the reactions differing with the composition.

Occurs coarse- or fine-grained or compact massive and in **modified isometric tetrahedrons,** or other inclined hemihedral forms.

Varieties.

The varieties are based upon the composition, some of the elements which frequently replace Copper to a considerable extent being: Zinc, Iron, Mercury, Silver, Lead, Tin, and Cobalt.

Compare with Chalcocite (p. 29) and Bournonite (p. 54).

Frequently contain enough Silver to make valuable ores of that metal, as well as of Copper.

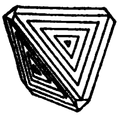

Fig. 21.

153. STEPHANITE. Ag_5SbS_4. **Hardness 2-2.5.**

Lustre. — Metallic.
Color. — Iron-black.
Streak. — Iron-black.
Very brittle. Uneven to subconchoidal fracture.

B. B. — On charcoal, fuses very easily with spurting to a globule, yielding the sublimate of antimony oxide. After long blowing, yields metallic Silver and the oxidized silver sublimate.

Occurs compact to granular massive, as small particles disseminated through the gangue, and in tabular or short prismatic, six-sided orthorhombic crystals.

Compare with Argentite (p. 23), Chalcocite (p. 29) and Tetrahedrite (p. 57).

A rare ore of Silver.

156. POLYBASITE. $(Ag,Cu)_9SbS_6$. **Hardness 2-3.**

Lustre. — Metallic.
Color. — Iron-black; **cherry-red in thin splinters.**
Streak. — Black.
Brittle. Uneven fracture.
Almost opaque.

B. B. — On charcoal, fuses easily with spurting to a globule, giving the antimony (sometimes arsenic) oxide sublimate.

Occurs usually in **six-sided, tabular orthorhombic crystals with beveled edges,** the basal-pinacoid being often marked with triangular striations.

The appearance is distinctive.

A very rare ore of Silver.

SULPHARSENATE.

158. ENARGITE. Cu_3AsS_4. **Hardness 3.**

Lustre. — Bright metallic.
Color. — **Iron-black.**
Streak. — **Black.**
Cleavage. — **Perfect prismatic** at angle of about 98°.
Brittle.

B. B. — On charcoal, fuses and gives faint sublimates of As, Sb and, often, Zn.

Occurs usually **columnar, cleavable massive**; also granular and in **lustrous orthorhombic crystals with striated prisms.**

The only mineral combining the above color, streak and cleavage.

An important ore of Copper.

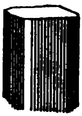

Fig. 22.

HALOGEN SALTS.

HALITE GROUP.

166. HALITE. NaCl. **Hardness 2.5.**

Lustre. — Vitreous.
Color. — Colorless white, yellow, brown, reddish, etc., due to impurities.
Streak. — White.
Cleavage. — **Perfect cubic.**
Transparent to translucent.
Taste. — **Saline.**

B. B. — Decrepitates violently. Fuses easily in the closed tube. Soluble in water.

Occurs granular to compact massive, cleavable massive, earthy, more rarely columnar or fibrous, and in isometric crystals, frequently showing cavernous faces. The fibrous variety is usually an efflorescence.

The taste is distinctive.

The uses of Halite (Salt) are well known. It is also the source of most of the Sodium and sodium compounds.

See Fig. 23.

169. CERARGYRITE. AgCl. **Hardness 1-1.5.**

Lustre. — **Waxy to resinous.**

Color. — Pearl-gray, greenish, whitish to colorless. Becomes violet-brown on exposure to light.

Streak. — White, shining.

Very sectile. Cuts like wax.

Translucent.

B. B. — Fuses very easily with an unpleasant odor, yielding a button of Ag. If rubbed on moistened Zinc or Iron, it swells, turns black and is reduced to spongy, metallic Silver.

Occurs usually as a crust, looking like wax or horn; sometimes columnar or in isometric crystals.

Varieties.

CERARGYRITE, **EMBOLITE** — Ag(Cl, Br), **BROMYRITE** — AgBr, **IODOBROMITE** — Ag(Cl, Br, I) and **IODYRITE** — AgI — are so nearly alike in appearance and value that they may all be conveniently grouped under the first name.

The appearance is so distinctive as to make confusion with other minerals very improbable.

Very important ore of Silver.

HALITE GROUP.

Members. — Halite, Cerargyrite, Embolite, Bromyrite, Iodobromite.

Composition. — Haloids.

Crystallization. — Holohedral isometric.

Additional. — All are rather soft, some very much so, but the group is not particularly well characterized.

Fig. 23. — Halite, Borax Lake, California.

175. FLUORITE. CaF_2. **Hardness 4.**

Lustre. — Vitreous.

Color. — Almost all colors, with green, violet, purple, colorless or white the commonest.

Streak. — White.

Cleavage. — **Perfect octahedral.**

Brittle.

Transparent to translucent.

B. B. — In forceps or on charcoal, fuses to an enamel, giving a red flame.

Occurs usually in groups of glassy, transparent cubical isometric crystals, rarely grouped in parallel position, forming an octahedron; also cleavable massive, coarse to fine granular and, rarely, earthy.

The crystals often show different tints by reflected and transmitted light and the massive varieties are often banded in zigzag lines.

The appearance, hardness and cleavage should be distinctive.

Compare with Halite (p. 61), Cryolite (p. 65), Quartz (p. 68), Calcite (p. 107) and Sodalite (p. 161).

Is used by smelters as a flux and in several arts and trades.

See Figs. 24 and 40.

183. CRYOLITE. Na_3AlF_6. **Hardness 2.5.**

Lustre. — **Greasy** to vitreous.

Color. — Colorless to snow-white, sometimes reddish or brownish.

Streak. — White.

Cleavage. — **Poor basal and prismatic at angles of nearly 90°.**

Brittle.

Translucent to transparent.

B. B. — On charcoal, fuses very easily with a yellow flame to a clear globule, opaque when cold.

Occurs cleavable massive and occasionally in monoclinic crystals resembling isometric cubes and octahedrons.

Often associated with Galenite (p. 26) or Siderite (p. 113).

The appearance, hardness and cleavage should be distinctive.

Compare with Halite (p. 61), Fluorite (p. 64), Quartz (p. 68) and Calcite (p. 107).

Was once the sole source of metallic Aluminum but is no longer used in the extraction of that metal except as a flux or bath.

It is in demand for the manufacture of several chemicals.

193. ATACAMITE. $Cu_2ClH_3O_3$. Hardness 3–3.5.

Lustre. — Adamantine to vitreous.
Color. — Bright green to various shades of the same.
Streak. — **Apple-green.**
Cleavage. — **Perfect pinacoidal.**
Usually transparent or translucent.

B. B. — **Gives an azure-blue flame without the aid of HCl.**

Occurs in radiating or confused aggregates of orthorhombic crystals; also granular to compact massive and as sand.

Compare with Malachite (p. 125) and Olivenite (p. 236).

A rare ore of Copper.

Fig. 24.—Fluorite, Cumberland, England.

OXIDES.

OXIDES OF SILICON.

210. QUARTZ. SiO_2. **Hardness 7.**

Phenocrystalline Varieties.

Lustre. — Splendent to nearly dull **vitreous**; sometimes greasy.

Color. — Colorless or white when pure; all colors due to impurities.

Streak. — White.

No cleavage. Conchoidal fracture when crystallized and uneven fracture when massive.

Transparent.

B. B. — Unaltered.

Occurs in distinct trapezohedral tetartohedral **hexagonal crystals with pyramidal terminations and horizontally striated prisms**; also radiating with drusy, crystalline surface, massive, coarse to fine granular, and as sand. In all cases there is a definite internal molecular arrangement, which either manifests itself in a definite external form or is made "evident" by means of polarized light and the compound microscope or through other proper tests.

Varieties.

The varieties are nearly all based on color, the various tints being due to impurities, often present in such minute quantities as to make it impossible to determine their character with certainty.

ROCK CRYSTAL.

Colorless, or almost colorless.

AMETHYST.

Purple to violet. Usually in crystals. Color probably due to Manganese.

ROSE.

Rose-red to pink. Always massive. Color possibly due to Titanium or Manganese.

Yellow Quartz, **FALSE TOPAZ** or **CITRINE.**

Light yellow. Massive or in crystals. Color probably due to Iron.

SMOKY QUARTZ, "SMOKY TOPAZ," or **CAIRNGORM.**

Dark brown to black. Usually complexly crystallized. Color due to some organic substance.

MILKY or **GREASY.**

White and nearly opaque. Usually massive.

FERRUGINOUS.

Containing, or coated with yellow oxide of iron.

AVENTURINE.

Spangled with glistening scales of various minerals.

Quartz with Inclosures.

Two of the commonest of these are Rutile (p. 95) and Tourmaline (p. 187).

CAT'S EYE or TIGER EYE.

Chatoyant, bright yellow to dark brown with included, parallel fibres of Crocidolite (p. 154).

Compare Phenocrystalline Quartz with Opal (p. 75), Beryl (p. 157), Iolite (p. 158), Nephelite (p. 159) and Topaz (p. 174).

Rock Crystal is used in the cheaper jewelry and is cut for optical purposes. Water-clear, polished spheres of this material are highly valued.

The colored varieties are also used in cheap jewelry and the Amethyst has been a prized gem from very ancient times.

Enormous quantities are used as a flux in smelting operations and also in the manufacture of abrasives, glass, etc.

See Figs. 28 and 46.

Cryptocrystalline Varieties.

Lustre. — **Dull to earthy**, sometimes **waxy**.
Color. — All colors, depending upon impurities.
Streak. — White.
No cleavage. Conchoidal fracture.
Translucent to opaque.

B. B. — Unaltered but, in general, it is acted upon more readily by attrition and chemicals — such as hydrofluoric acid — than the Phenocrystalline material.

Occurs **fine grained massive** and mammillary, botryoidal, stalactitic, nodular, or filling or lining cavities in rocks. It never occurs in crystals since it is made up of a confused jumble of extremely minute particles of Phenocrystalline Quartz, its structure being, therefore, "hidden." These minute particles — and, therefore, the whole mass — are, however — like Phenocrystalline material — crystallized silica.

Varieties.

The varieties are based upon both structure and color. Many kinds contain a considerable proportion of Opal silica (p. 75), which gives a higher lustre and makes the grain finer.

(A) *Chalcedonic Quartz.*

It is convenient, but not strictly accurate, to group all the varieties which show a **uniform coloration** under this term.

CHALCEDONY.

Pale blue, gray or drab.

CARNELIAN.

Translucent, pale to deep red.

CHRYSOPRASE.

Apple-green, the color being due to NiO.

PRASE.

Dull, leek green.

JASPER.

Opaque, dull red, brown, yellow, etc.

HELIOTROPE OR BLOODSTONE.

Prase, showing small spots of blood-red Jasper.

FLINT.

Smoky-gray or brown to nearly black nodules, occurring in chalk. Translucent and containing considerable Opal silica (p. 75), which is apt to be dissolved out on the surface, leaving a white, porous coating of crystalline silica.

CHERT.

Impure, coarse-grained, opaque, gray or brown Flint.

HORNSTONE.

Like Chert but is apt to be finer grained and more splintery, and was deposited in horizontal layers.

BASANITE, LYDIAN STONE OR TOUCH-STONE.

Velvety black.

(B) **AGATE.**

Material showing Chalcedonic Quartzes of **two or more different colors.** The colors are white, gray, light to dark brown, red, black (rare), and light blue or other tints (very rare). Material showing very brilliant or strongly contrasting colors has been artificially tinted.

Banded Agate.

The materials of different colors are arranged in **curved, parallel bands.**

Irregularly clouded Agate.

RUIN or **FORTIFICATION AGATE.**

When polished, shows peculiar markings, described by the name.

MOSS AGATE.

Translucent material with brown or green, moss-like or dendritic splotches scattered throughout the mass.

(C) **ONYX.**

Bands of different colored materials arranged in **flat, parallel planes.**

SARDONYX.

Bands of Carnelian with either white, brown or black material.

(D) *Pseudomorphous Quartz.*

Under this head are found the **PETRIFIED** and **AGATIZED WOODS.**

(E) Rock Quartz.

QUARTZ SANDSTONE.

Fine grains cemented together with SiO_2, Fe_2O_3 or $CaCO_3$.

ITACOLUMITE.

Flexible sandstone. A considerable proportion of mica scales joining the Quartz grains allows the material to be easily bent without breaking.

QUARTZITE.

A sandstone with the interstices between the grains completely filled with Phenocrystalline Quartz, forming a compact, granular rock.

Compare Cryptocrystalline Quartz with Opal (p. 75), Datolite (p. 179) and Thomsonite (p. 198).

The colored varieties are cut and polished in enormous quantities, being used in jewelry and as ornamental stones.

Sandstone is one of the most important of building materials and Quartzite is used in the same way but to a less extent.

Quartz is the commonest solid substance on the surface of the earth.

See Fig. 29.

212. OPAL. $SiO_2 + n\ H_2O$. **Hardness 5.25-6.5.**

Lustre. — **Greasy vitreous.**
Color. — All colors.
Streak. — White.
Very smooth, conchoidal fracture.
Transparent to translucent.

B. B. — Infusible, but becomes opaque. Some yellow varieties turn red.
More readily soluble in hydrofluoric acid and alkalies than Quartz.

Occurs massive in veins and filling cavities in rocks; also botryoidal, stalactitic, and earthy. **Is amorphous silica.**

Varieties.

The varieties are based on color and structure.

PRECIOUS OPAL.

Milky, blue, yellow, brown, red or black opal, **showing internal reflections of various colors,** commonly red or green.

FIRE OPAL.

Red, brown or yellow material, showing fire-like reflections but no play of color as in Precious Opal.

COMMON OPAL.

Included under this head are all the typical opals without play of color or other special, distinguishing features.

OPAL-AGATE.

Agate-like in structure.

JASP-OPAL.

Of the color of red or yellow Jasper.

WOOD-OPAL.

Wood, petrified with Opal. The colors are sometimes exquisite. May or may not show the woody structure.

HYALITE.

Colorless, transparent drops or botryoidal coatings.

GEYSERITE OR SILICEOUS SINTER.

Opaque, rather porous, usually dull lustered material deposited from hot, siliceous water.

FIORITE OR PEARL SINTER.

Translucent, porous to firm incrustations, showing a pearly lustre, deposited from hot, siliceous water and formed also by the decomposition of siliceous volcanic rocks about fumeroles.

DIATOMACEOUS EARTH, INFUSORIAL EARTH, FULLERS' EARTH, TRIPOLITE, Etc.

A very fine-grained, white earth, resembling Chalk (p. 109) but harsher to the touch and capable of scratching glass when rubbed upon it. It is composed of the siliceous remains of very minute plants or animals and is either loose or moderately compacted.

Compare with Quartz (p. 68), Datolite (p. 179) and Thomsonite (p. 198).

Compare the earthy varieties with Chalk (p. 109) and Magnesite (p. 112).

The precious and Fire Opals are very beautiful gems. Up to recent years they were believed to bring ill-luck to the wearer but they are now very popular.

Other varieties, particularly Wood Opal, are cut and polished for ornamental stones.

The earthy varieties form the base of most metal-polishing powders and have many other uses in the arts and trades.

ANHYDROUS OXIDES OF THE SEMI-METALS.

221. CERVANTITE. Sb_2O_4. Hardness 4-5.

Lustre. — Greasy or pearly to dull.
Color. — Shades of **yellow** to nearly white or reddish white.
Streak. — Yellowish white to white.
Brittle. — Conchoidal to uneven fracture.
Opaque.

B. B. — In forceps, infusible and unaltered. On charcoal readily reduced to metallic Antimony.

Occurs usually massive with a prismatic structure, as a crust or powder, and in indistinct, acicular orthorhombic crystals.

Usually associated with Stibnite (p. 20) **and Other Antimony ores, being formed by their alteration.**

The association is usually distinctive.

ANHYDROUS OXIDES OF THE METALS.

PROTOXIDES.

224. CUPRITE. Cu_2O. **Hardness 3.5-4.**

Lustre. — Adamantine or sub-metallic to dull.
Color. — Various shades of red; sometimes nearly black. Often **carmine.**
Streak. — Brownish red, **shining.**
Brittle.
Transparent to opaque.

B. B. — On charcoal, blackens, fuses and is reduced to metallic Copper. In the forceps, fuses and colors the flame emerald-green.

Occurs coarse to fine grained massive, earthy, and **in simple or complicated, well formed or elongated isometric crystals,** which are really trapezohedral hemihedral but the forms rarely make this apparent.

Compare with Cinnabar (p. 33), Proustite (p. 56) and Hematite (p. 83).

An important ore of Copper.

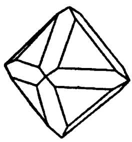

FIG. 25.

228. ZINCITE. ZnO. Hardness 4–4.5.

Lustre. — Sub-adamantine to sub-metallic.
Color. — **Dark red to orange-red.**
Streak. — **Orange-yellow.**
Cleavage. — **Perfect basal,** not always apparent.
Translucent to sub-translucent.
Brittle.

B. B. — Infusible. In closed tube, blackens, but regains the original color when cool.

Occurs in **lamellar masses**, granular and, rarely, in hemimorphic hexagonal crystals.

Usually associated with Calcite (p. 107) **Franklinite** (p. 90) **and Willemite** (p. 168).

Compare with Realgar (p. 18).

An ore of Zinc.

SESQUIOXIDES.

HEMATITE GROUP.

231. CORUNDUM. Al_2O_3. **Hardness 9.**

Lustre. — Vitreous to adamantine.
Color. — All colors. Usually gray when massive.
Streak. — White.
Perfect rhombohedral — nearly rectangular — parting due to twinning. Parting faces usually finely cross-hatched with striations at nearly right angles.
Brittle. Very tough when compact.
Translucent to transparent.

B. B. — Unaltered.

Occurs pseudo-cleavable massive, coarse to fine granular, and in rhombohedral hemihedral hexagonal crystals, the basal pinacoid being frequently triangularly striated. The larger crystals are apt to be rough and rounded.
It is also found in the form of water-rounded pebbles.

Varieties.

(A) *Gem Varieties.*

These are **transparent and often of fine color.** The trade name for all colors is Sapphire. The varieties are based upon differences of color.

ORIENTAL EMERALD.

Light to deep **green.**

ORIENTAL RUBY.

Red with a slight purple tint.

ORIENTAL SAPPHIRE.

Light to deep **blue.** The **STAR SAPPHIRE** shows a star-like, opalescent figure when viewed in the direction of the vertical axis of the crystal.

ORIENTAL TOPAZ.

Yellow.

ORIENTAL AMETHYST.

Purple.

(B) ADAMANTINE SPAR.

Coarse crystals, **masses showing a well developed parting,** and granular. Slightly translucent.

(C) EMERY.

Opaque, finely granular material, of dark color, and mixed with Magnetite (p. 89) or Hematite (p. 83).

The hardness is sufficient to distinguish from all similar minerals.

The gem varieties are very beautiful and extremely valuable, some varieties costing more than Diamonds of equal weight.

Adamantine Spar and Emery are the most important abrasive substances and great quantities of both are used for grinding and polishing.

FIG. 26.

232. HEMATITE. Fe_2O_3. Hardness 5.5–6.5.

Lustre. — Metallic to earthy.
Color. — Steel-gray to black, reddish black and red.
Streak. — **Bright red to reddish brown.**
No cleavage but often possesses a foliated or lamellar structure due to parting parallel to the basal pinacoid.
Uneven fracture. Brittle.

B. B. — Infusible. On charcoal, becomes magnetic.

Occurs in compact platy, columnar, radiated, kidney-shaped or micaceous masses; also granular, loose and earthy, oolitic, and in rhombohedral hemihedral hexagonal crystals.

The crystals are thin tabular and grouped in more or less parallel position, larger and thicker and often showing rounded faces, or scaly to micaceous.

Varieties.

SPECULAR IRON.

Very brilliant plates or crystals.

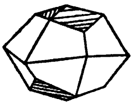

FIG. 27.

RED-OCHRE or **RUDDLE.**

Earthy, more or less impure material.

MARTITE.

Pseudomorph after Magnetite (p. 89).

Compare with Cinnabar (p. 33), Cuprite (p. 78), Ilmenite (p. 84), Magnetite (p. 89) and Limonite (p. 102).

The greatest proportion of all the iron-ore mined is Hematite. It is also used in considerable amounts for manufacturing cheap paint, as chalk used in marking assay crucibles, as a polishing powder, etc.

See Fig. 31.

233. ILMENITE. $FeTiO_3$. Hardness 5–6.

Lustre. — Submetallic.
Color. — Iron-black.
Streak. — **Reddish brown** to brownish black.
Conchoidal fracture. Brittle.
Attracts magnetic needle feebly.

B. B. — Gives following test for iT.
Grind *very fine* and boil with HCl in a test-tube until dissolved to a yellow liquid, which, if Sn or Zn be boiled in it, will turn to violet.

Occurs compact massive, granular, in thin plates, as imbedded grains, and as sand. Rarely in thick tabular or acute rhombohedral tetartohedral hexagonal crystals.

Compare with Hematite (p. 83), Spinel (p. 86), Magnetite (p. 89), Franklinite (p. 90), Chromite (p. 91) and Limonite (p. 102).

Is used in the lining of puddling furnaces.
It is very difficult to smelt and this fact makes other iron ores with which it may be associated less valuable than they otherwise would be.

HEMATITE GROUP.

Members. — Corundum, Hematite, Ilmenite.

Composition. — Sesquioxides (M_2O_3).

Crystallization. — Rhombohedral hemihedral and rhombohedral tetartohedral hexagonal.

The group is not well characterized.

FIG. 28. — Quartz, Hot Springs, Arkansas.

FIG. 29. — Moss Agate.

INTERMEDIATE OXIDES.

SPINEL GROUP.

234. SPINEL. $MgO.Al_2O_3$. **Hardness 8.**

Lustre. — **Vitreous** to almost dull.
Color. — Commonly black but also red, blue, green, yellow, and brown.
Streak. — **White.**
Brittle. Conchoidal fracture.
Transparent to opaque.

B. B. — Infusible, but may change color.

Occurs usually in simple or twinned octahedral crystals. Also as water-worn pebbles.

The surface of some varieties is apt to be hydrated and so soft as to be easily scratched with a knife.

Varieties.

RUBY SPINEL or BALAS RUBY.

A Magnesia Spinel, red in color and transparent to translucent.

CEYLONITE.

An Iron Magnesia Spinel, dark green, brown or black in color and opaque.

CHLOROSPINEL.

A Magnesia Iron Copper Spinel, grass-green in color.

PICOTITE or CHROME SPINEL.

A Magnesia Chromium Iron Spinel, dark yellowish brown to greenish brown in color and translucent to nearly opaque.

Note; All varieties contain Aluminum.

Compare with Corundum (p. 81) and the other members of this group.

The transparent varieties are semiprecious and are used as gems.

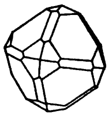

Fig. 30.

236. GAHNITE. $ZnO.Al_2O_3$. Hardness 7.5–8.

Lustre. — Vitreous to greasy.
Color. — **Dark green to greenish black**, also bluish black, yellowish or grayish brown.
Streak. — **Gray** or grayish green.
Brittle. Conchoidal to uneven fracture.
Sub-transparent to opaque.

B. B. — Infusible and yields Zn tests with flux.

Occurs in grains or octahedral crystals.

Compare with Spinel (p. 86).

237. MAGNETITE. $FeO.Fe_2O_3$. Hardness 5.5–6.5.

Lustre. — Metallic to sub-metallic or dull.
Color. — Iron black.
Streak. — Black.
Octahedral parting due to twinning often well developed.
Strongly attracted by the magnet and is sometimes itself magnetic.
Brittle. Sub-conchoidal to uneven fracture.

B. B. — Practically infusible.

Occurs compact and laminated massive, coarse to fine granular, as sand, and in octahedral crystals, the faces of which often show octahedral twinning striations or striations produced by oscillation of the octahedron and dodecahedron faces.

Variety.

LODESTONE.

A natural magnet, possessing the property of polarity.

This is the only mineral which is strongly attracted by the magnet.

A very pure and valuable ore of Iron.

239. FRANKLINITE. $\left\{\begin{matrix}Fe\\Zn\\Mn\end{matrix}\right\}O.\left\{\begin{matrix}Fe\\Mn\end{matrix}\right\}_2O_3$. Hardness 5.5–6.5

Lustre. — Metallic to dull.
Color. — Iron-black.
Streak. — **Reddish brown to brownish black.**
Octahedral parting due to twinning usually well developed.
Sometimes slightly magnetic.
Brittle. Conchoidal to uneven fracture.

B. B. — Infusible.

Occurs compact to platy massive, coarse to fine granular, and in octahedral crystals which pass into rounded grains.

Usually associated with Zincite (p. 80), **Calcite** (p. 107) **and Willemite** (p. 168).

Compare with Hematite (p. 83), Ilmenite (p. 84), the other members of this group and Limonite (p. 102).

It is an ore of Zinc and one of the by-products of its recovery is used in the making of manganese steel. A poor grade of dark paint has been made of the ground material.

See Fig. 32.

241. CHROMITE. $FeO.Cr_2O_3$. Hardness 5.5.

Lustre. — **Vitreous, splendent,** to metallic or sub-metallic.
Color. — Black.
Streak. — **Dark brown.**
Brittle. Uneven fracture but **each grain shows a very smooth conchoidal fracture with a high lustre.**

B. B. — Infusible, but may fuse slightly in the reducing flame and then becomes magnetic.

Occurs usually coarse to fine granular or as disseminated grains; also compact massive and, rarely, in small octahedral crystals.
Usually associated with Serpentine (p. 214) **and often showing a finely botryoidal, green coating of ZARATITE,** a hydrated, basic nickel carbonate.

Compare with Hematite (p. 83), Ilmenite (p. 84) and the other members of this group, particularly Magnetite (p. 89).

Chromite is the source of nearly all the Chromium chemical compounds and chrome paints, and is also used in making a hard steel.

SPINEL GROUP.

Members. — Spinel, Gahnite, Magnetite, Franklinite, Chromite.

Composition. — Intermediate oxides $(\overset{II}{R}O.\overset{III}{R}_2O_3)$.

Crystallization. — Holohedral isometric.

Additional. — All are too hard to be scratched with a knife.

FIG. 31. — Martite, Twin Peaks, Utah.

FIG. 32. — Franklinite in Calcite, Franklin Furnace, New Jersey.

242. CHRYSOBERYL. $BeO.Al_2O_3$. **Hardness 8.5.**

Lustre. — Vitreous.

Color. — Light yellow-green to emerald-green. **The dark varieties are sometimes purplish red by transmitted light.**

Streak. — White.

Brittle. Uneven to conchoidal fracture.

Transparent to translucent.

B. B. — Unaltered.

Occurs in thin to thick, tabular orthorhombic crystals with the macro-pinacoid vertically striated. Contact or polysynthetic twins are common, these being usually tabular and showing pointed or featherlike striations on the largest faces.

Sometimes found as water-worn pebbles, resembling green glass. This and other varieties may exhibit a bluish chatoyancy, or may be asteriated.

Varieties.

ALEXANDRITE.

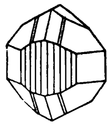

FIG. 33.

Emerald-green, but purplish red by transmitted light. Probably colored by Cr.

CAT'S EYE or **CYMOPHANE.**

Chatoyant, yellowish green material.

Compare with Emerald (p. 157), Beryl (p. 157), Chrysolite (p. 167), Epidote (p. 181) and Tourmaline (p. 187).

The transparent varieties are valued and used as gems.

DIOXIDES.

RUTILE GROUP.

248. CASSITERITE. SnO_2. Hardness 6–7.

Lustre. — Adamantine to dull.
Color. — Brown, black or red; sometimes gray or yellow.
Streak. — White or **very light brown.**
Brittle. Uneven to sub-conchoidal fracture.
Opaque to translucent.
S. G. — 6.8–7.1.

B. B. — Infusible. On charcoal, powder becomes luminous and yellow.

Occurs in well formed tetragonal crystals, often short and forming "knee-shaped" contact twins; as disseminated grains, and, most frequently, as botryoidal or reniform masses or water-worn pebbles with a concentric or radiating fibrous structure; also compact to granular massive.

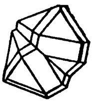

FIG. 34. "Knee-Shaped" Twin.

Varieties.

TIN-STONE.

In crystals and massive.

WOOD TIN.

Botryoidal and reniform varieties, with radiating fibrous, concentric structure and resembling dry wood in colors.

STREAM TIN.

Water-worn pebbles or grains.

Compare with Rutile (p. 95) and Wolframite (p. 259).

The source of all Tin.

250. RUTILE. TiO_2. Hardness 6–6.5.

Lustre. — Adamantine to sub-metallic.

Color. — Reddish brown, red, yellowish, black, etc. **Deep red by transmitted light.**

Streak. — Light brown.

Cleavage. — Poor prismatic sometimes developed.

Brittle. Uneven to sub-conchoidal fracture.

Transparent to opaque.

S. G. — 4.2.

B. B. — Infusible. Yields Ti test described under Ilmenite (p. 84).

Occurs in tetragonal crystals which often show **vertical striations or deep furrows on the prism faces.** Contact twins of several habits are common. These include "knee-shape" twins, "spear-head" twins, "sixlings" and "eightlings." Often found slender acicular with deep striations and indistinct crystallization; also as hair-like inclusions in other minerals. Occasionally occurs compact massive.

Compare with Cassiterite (p. 94).

It is used to give the required bluish tint to artificial teeth. Its presence seriously impairs the value of iron ores, with which it is frequently associated.

See Fig. 35.

RUTILE GROUP.

Members. — Cassiterite, Rutile.

Composition. — Dioxides.

Crystallization. — Tetragonal.

Additional. — Both are too hard to be scratched with a knife, are frequently of a brown color and adamantine lustre and often occur in "knee-shaped" twins.

FIG. 35. — Rutile "Eightling," Arkansas.

253. BROOKITE. TiO_2. Hardness 5.5–6.

Lustre. — Adamantine to sub-metallic.
Color. — Brown, yellowish, reddish, and black.
Streak. — White to yellowish or grayish.
Brittle. Uneven to sub-conchoidal fracture.
Translucent to opaque.

B. B. — Infusible. Yields Ti test described under Ilmenite (p. 84.).

Occurs either in thin, tabular, translucent, brown orthorhombic crystals, which are often highly modified, or in black, opaque pyramidal crystals which are often dull in lustre.

The appearance is distinctive.

Too rare to have any use.

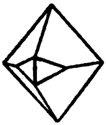

FIG. 36.

254. PYROLUSITE. MnO_2. **Hardness 1-2.5.**

Lustre. — Metallic to dull.
Color. — Black to dark steel-gray.
Streak. — **Black, often sooty.**
Rather brittle.
Usually soils the fingers.

B. B. — Infusible, but becomes brown.

Occurs in indistinct, probably pseudomorphic, crystals, as radiating needles or fibres, as velvety crusts, and, more rarely, granular to compact massive and stalactitic.

Often found in alternate layers with Psilomelane (p. 106).

The hardness and streak are sufficient to distinguish Pyrolusite from all the minerals with which it is apt to be confused.

It is used to decolorize glass when the tints are due to the presence of FeO, to color glass purple, in the manufacture of electric dry-batteries, chlorine, and oxygen, and as an oxidizing agent in many ways.

HYDROUS OXIDES.

DIASPORE GROUP.

256. DIASPORE. $Al_2O_3 . H_2O$. **Hardness 6.5-7.**

Lustre. — Vitreous. Pearly on cleavage face.
Color. — Pink, violet, green, brown, yellowish, gray, white or colorless. Sometimes dichroic, violet and green.
Streak. — White.
Cleavage. — **Perfect pinacoidal.**
Very brittle.
Transparent to sub-translucent.

B. B. — Infusible and usually decrepitates.

Occurs in thin scales, flat, prismatic orthorhombic crystals, and foliated massive.

Compare with Lepidolite (p. 203) and Margarite (p. 207).

257. GOETHITE. $Fe_2O_3 . H_2O$. Hardness 5–5.5.

Lustre. — Sub-adamantine or silky to dull.
Color. — Yellow, dark brown, brownish black. Rarely reddish but often blood-red by transmitted light.
Streak. — Brownish to ochre-yellow.
Cleavage. — **Perfect pinacoidal.**
Brittle.
Opaque to translucent.

B. B. — Thin splinters fuse black and magnetic.

Occurs fibrous or needle-like, foliated or in scales, as velvety crusts, botryoidal or reniform or stalactitic with a concentric and radiating structure, and **in indistinct, vertically striated, prismatic orthorhombic crystals.**

Compare with Limonite (p. 102), from which it cannot usually be distinguished and with which it is classed commercially.

An ore of Iron.

258. MANGANITE. $Mn_2O_3 . H_2O$. **Hardness 4.**

Lustre. — Metallic to sub-metallic.
Color. — Iron-black to dark steel-gray.
Streak. — **Reddish brown to brownish black.**
Cleavage. — **Perfect pinacoidal.**
Brittle.

B. B. — Infusible.

Occurs in long, **deeply striated, prismatic orthorhombic crystals with basal-pinacoids**, in bundles of such crystals, and, rarely, massive, columnar, granular or stalactitic. Usually associated with other Mn minerals.

The hardness and streak are sufficient to distinguish it from all similar minerals.

DIASPORE GROUP.

Members. — Diaspore, Goethite, Manganite, Limonite, Bauxite.

Composition. — Hydrous sesquioxides.

Crystallization. — Orthorhombic and amorphous.

The group is not well characterized.

262. BRUCITE. $MgO.H_2O$. **Hardness 2.5.**

Lustre. — **Pearly or waxy** to vitreous.
Color. — White or tinted.
Streak. — White.
Cleavage. — **Good pinacoidal. Cleavage plates flexible.**
Sectile.
Usually **translucent.**

B. B. — Infusible, but glows brilliantly.

Occurs in foliated masses, fibrous and, rarely, in tabular rhombohedral hemihedral hexagonal crystals.

Compare with Muscovite (p. 202), Talc (p. 217) and Gypsum (p. 255).

269. PSILOMELANE. $MnO_2 . H_2O + \left\{ \begin{matrix} K_2O \\ BaO \end{matrix} \right\}.$

Hardness ±6.

Lustre. — Sub-metallic to dull.
Color. — Iron-black to dark gray.
Streak. — **Brownish or grayish black, shining.**
Smooth, conchoidal fracture.
Opaque.

B. B. — Infusible.

Occurs in **smooth, amorphous, botryoidal or stalactitic masses, or in layers with Pyrolusite** (p. 98).

Varieties.

WAD or **BOG MANGANESE.**

Impure mixture of Mn, Fe, Co, Cu, Pb, etc., oxides. Usually loose and earthy with a brown streak and soft enough to soil the fingers. Sometimes harder and compact.

The hardness, combined with the appearance, is distinctive of Psilomelane.

This is the commonest Manganese ore and its uses are the same as described under Pyrolusite (p. 98), but its products are less pure.

ANHYDROUS CARBONATES.

CALCITE GROUP.

270. CALCITE. $CaCO_3$. **Hardness 3.**

Lustre. — Vitreous to earthy.

Color. — Colorless or white, and pale to deep shades of yellow, blue, red, violet, green, and brown to black when impure.

Streak. — White.

Cleavage. — **Very perfect rhombohedral at angles of 105° 5′ and 74° 55′**, being parallel to the "unit rhombohedron" (+R).
A good parting parallel to $-\frac{1}{2}$ R often developed by twinning.

Transparent to opaque.

Double refraction very strong.

B. B. — Infusible but becomes opaque and gives red flame.
Easily soluble with effervescence in cold, dilute HCl or in any other condition of that acid.

Occurs in crystals, cleavable to compact massive, coarse to fine granular, stalactitic, nodular, earthy and, rarely, fibrous or lamellar.

Varieties.

Crystals.

The crystallization is rhombohedral hemihedral hexagonal.

Most Calcite crystals are found to fall under one of the following habits.

1. *Flat rhombohehral.* — ½ R is main form. Called **NAIL-HEAD SPAR.**
2. *Steep rhombohedral.* — 2 R is main form.
3. *Steep scalenohedral.* Acutely pointed and often complexly rounded with steep scalenohedrons the main forms. Called **DOG-TOOTH SPAR.**
4. *Prismatic.* Long and slender. May show prisms of all three orders. Usually terminated by habits 1 or 3, above.
5. *Tabular.* Very flat rhombohedrons and scalenohedrons with, rarely, a basal-pinacoid.
   On all varieties, striations due to oscillation of faces are common.

Twinning parallel to — ½ R is common and the basal-pinacoid is also sometimes a twinning plane. The former habit is not uncommon on massive, cleavable material and produces twinning striations on cleavage faces.

In orienting broken material, remember that the vertical axis must come out at the intersection of three cleavage faces *which make equal angles with each other*.

ICELAND SPAR.

Transparent, flawless, colorless, cleavable material.

Massive.

SATIN SPAR.

Fine fibrous with a silky lustre.

ARGENTINE.

Laminated, with a pearly lustre.

MARBLE.

Coarse to fine granular, crystalline.

LIMESTONE.

Dull, compact, noncrystalline.

COQUINA.

A rock made up of shells, etc., cemented together into a hard mass.

LITHOGRAPHIC STONE.

A compact limestone with a very fine grained, even texture.

MARL.

Earthy material containing much clay.

OOLITIC LIMESTONE.

Composed of small spherical particles, looking like fish roe.

PISOLITIC LIMESTONE.

Same as above but the particles are larger, often as large as a small pea.

CHALK.

Soft, white, earthy material, being made up of the remains of deep sea organisms.

Deposited from Springs, Streams or in Caverns.

STALACTITE, STALAGMITE, MEXICAN ONYX.

Banded or concentric material, with a radiating structure, formed in caves. Stalactites hang from the roof and Stalagmites form on the floor, under the drip of the former.

TRAVERTINE.

Banded material, deposited from streams or springs.

CALCAREOUS TUFA.

Very porous Travertine.

Compare with Aragonite (p. 118).
Distinguished from all other similar minerals by acid test, cleavage or hardness.

The uses of Calcite are very many.

Iceland Spar is rare and valuable, being used by opticians. Marble and Limestone are important building materials and the former is carved for various purposes. The latter is used in enormous quantities in the manufacture of Lime, as a flux in smelting, in the manufacture of CO_2 and other chemicals and in many arts and trades.

Coquina is a fine paving material.

Lithographic Stone is scarce and valuable since it must stand many tests.

The banded material often forms a beautiful and valuable ornamental stone.

See Fig. 39.

271. DOLOMITE. (Ca, Mg) CO_3. Hardness 3.5-4.

Lustre. — Vitreous to pearly.
Color. — White, pink, yellow, brown, gray.
Streak. — White.
Cleavage. — **Perfect rhombohedral at angles of 106° 15′ and 73° 45′.**
Translucent.

B.B. — Infusible. **Fragments effervesce vigorously in warm, dilute HCl, but the action is very slow in cold acid.**

Occurs coarse to fine granular or compact massive, and in **warped rhombohedral crystals**, usually grouped with the sharp edges outward, forms other than the unit rhombohedron being rare.

Varieties.

PEARL SPAR.

Crystals with a pearly lustre.

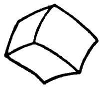

FIG. 38.
Warped Rhombohedron.

GOLDEN DOLOMITE.

Crystals with a yellowish brown or golden coating.

Distinguished from all similar minerals by acid test and appearance.

The uses are similar to those of Calcite, much Limestone being Dolomitic. It is not used, however, in making some of the chemical products made from Calcite (p. 107). Epsom Salts are made from Dolomite.

272. MAGNESITE. $MgCO_3$. **Hardness 4-4.5.**

Lustre. — **Earthy** when massive. Vitreous when crystallized.

Color. — **White**, yellow or grayish when massive. Brown to **black** when crystallized, due to organic impurities.

Streak. — White.

Conchoidal fracture when massive.

Cleavage. — **Perfect rhombohedral at angles of 107° 24′ and 72° 36′ when crystallized.**

Opaque when massive. Opaque to translucent when crystallized.

B. B. — Infusible. **Will effervesce vigorously only in hot, concentrated, or boiling, dilute HCl.**

Occurs in chalk-like lumps, often associated with Serpentine (p. 214); also, rarely, fibrous and in steep rhombohedral crystals, showing a basal plane and resembling distorted octahedrons. Rarely, cleavable massive.

The massive material should be compared with the Opal earths (p. 76), Chalk (p. 109), Hydrozincite (p. 127) and Thaumasite (p. 222). Compare crystals with Spinel (p. 86).

It is used as a lining for converters, etc., and in the manufacture of CO_2, epsom salts and magnesia.

273. SIDERITE. $FeCO_3$. Hardness 3.5–4.

Lustre. — Vitreous to pearly and dull.

Color. — **Brown or gray.** Rarely greenish, reddish, yellowish or black.

Streak. — White to yellowish.

Cleavage. — **Perfect rhombohedral at angles of 107° and 73°.**

Translucent to opaque.

B. B. — On charcoal, decrepitates, blackens, becomes magnetic and fuses with great difficulty in thin splinters.
Will effervesce vigorously only in hot, concentrated HCl.

Occurs cleavable massive, coarse to fine granular and in warped rhombohedrons like Dolomite (p. 111); also compact and earthy and, rarely, oolitic, botryoidal or fibrous.

Varieties.

SPHAEROSIDERITE or **CLAY-IRONSTONE.**

Compact material containing much clay, the former being concretionary.

Compare with Sphalerite (p. 30), Dolomite (p. 111) and Smithsonite (p. 115).

A rather uncommon ore of iron, but it is so pure that the iron made from it commands a premium.

274. RHODOCHROSITE. $MnCO_3$. Hardness 3.5–4.5.

Lustre. — Vitreous to pearly.

Color. — **Dark red or rose-red when transparent; pink** or brownish red when translucent or opaque. **Surface becomes black upon exposure.**

Streak. — White.

Cleavage. — **Perfect rhombohedral at angles of 107° and 73°.**

Transparent to opaque.

B. B. — Infusible but decrepitates strongly and becomes gray, brown or black. **Will effervesce vigorously only in hot, concentrated, or boiling, dilute HCl.**

Occurs cleavable massive, granular, in warped rhombohedrons like Dolomite (p. 111), and in complexly modified rhombohedral crystals; also, rarely, compact, botryoidal and incrusting.

The color will distinguish from all similar minerals except manganiferous Dolomite (p. 111) **and Rhodonite** (p. 149). To distinguish from these, apply hardness and acid tests, respectively.

Valueless, but is usually associated with ores of Silver, Manganese, Lead and Copper.

See Fig. 40.

275. SMITHSONITE. $ZnCO_3$. **Hardness 5.**

Lustre. — Vitreous to resinous or dull.
Color. — Brown, green, yellow or gray. White when pure.
Streak. — White.
Cleavage. — Perfect rhombohedral at angles of 107° 40′ and 72° 20′. Not always very evident.
Translucent to opaque.

B. B. — Infusible. **Effervesces vigorously in any kind of HCl except cold dilute.**

Occurs **stalactitic, botryoidal or as crystalline crusts; also in dull lustered, earthy, cavernous masses.** Rarely granular, powdery or in rhombohedral crystals.

Variety.

DRY BONE.

The dull lustered, massive, cavernous material, resembling closely the substance from which it gets its name.

Compare with Sphalerite (p. 30), Siderite (p. 113) and Calamine (p. 186).

A very valuable ore of Zinc, since it requires no roasting before reduction.

CALCITE GROUP.

Members. — Calcite, Dolomite, Magnesite, Siderite, Rhodochrosite, Smithsonite.

Composition. — Carbonates.

Crystallization. — Rhombohedral hemihedral hexagonal.

Additional. — All have a perfect rhombohedral cleavage at an angle of from 105° to 107° 40′, varying with the composition.
All are relatively soft, varying from 3 to 5 with the composition.
All effervesce in some condition of HCl, the ease of effervescence varying with the composition.
All may have a vitreous lustre.

FIG. 39. — Calcite, Ouray County, Colorado.

Fig. 40.—Rhodochrosite with Octahedral Fluorite, Saguache County, Colorado.

ARAGONITE GROUP.

277. ARAGONITE. $CaCO_3$. Hardness 3.5–4.

Lustre. — Vitreous.
Color. — Usually white; sometimes yellow, gray, green or violet.
Streak. — White.
Cleavage. — **None** or poor pinacoidal.
Fracture. — Sub-conchoidal.
Transparent to translucent.

B. B. — Infusible, but may whiten and fall to pieces. **Effervesces vigorously in cold, dilute HCl, or in any other condition of that acid.**

Occurs in distinct **orthorhombic crystals** which frequently show striations across the terminations, due to twinning; in repeatedly twinned crystals which closely resemble a hexagonal basal pinacoid, prism, etc.; **in radiating aggregates of acicular crystals with a six-sided cross-section; also in coral-like shapes,** stalactitic and incrusting, sometimes columnar to fine fibrous.

Varieties.

FLOS FERRI.

Delicate, interlacing and branching stems, closely resembling Tree Corals. Associated with Iron ores.

Compare with Quartz (p. 68), Calcite (p. 107), Strontianite (p. 121) and Natrolite (p. 196).

Rarely occurs in sufficiently large masses to pay to use it in the manufacture of the products for which Calcite (p. 107) is used.

A decisive method of distinguishing between Calcite (p. 107) and Aragonite is the following:

Powder the substance to be tested and boil in dilute cobalt nitrate. If the substance is Calcite, the powder will turn to a green or blue, and, if Aragonite, to a lilac or purple.

See Fig. 44.

FIG. 41.—Twin.

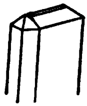

FIG. 42.

279. WITHERITE. $BaCO_3$. Hardness 3–4.

Lustre. — **Greasy vitreous.**
Color. — Yellowish, grayish or white.
Streak. — White.
Cleavage. — **None.**
Uneven to sub-conchoidal fracture.
Translucent.
S. G. — **4. 3.**

B. B. — Fuses easily and gives a Ba flame.
Effervesces vigorously in very dilute, cold HCl but not in cold, concentrated HCl.

Occurs in masses which frequently show cavities lined with indistinct crystals or with globular forms; also in twinned orthorhombic crystals closely resembling a hexagonal prism and steep pyramid, the prism being deeply, horizontally striated or grooved; sometimes granular; rarely fibrous.

The lustre, specific gravity and B. B. tests are distinctive.

Used in refining beet-sugar and to adulterate white lead.

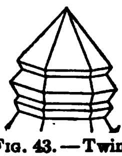

Fig. 43. — Twin.

280. STRONTIANITE. $SrCO_3$. Hardness 3.5–4.

Lustre. — Vitreous to greasy.
Color. — White or colorless and pale shades of yellow, green and brown.
Streak. — White.
Cleavage. — **Fair prismatic at angles of 117° 19′ and 62° 41′.**
Translucent.
S. G. — **3.7.**

B. B. — Fuses only on thin edges, but swells and shows Sr flame.
Effervesces vigorously in very dilute, cold HCl but not in cold, concentrated HCl.

Occurs in **radiating aggregates of imperfect, prismatic crystals**; sometimes granular, fibrous or in globular forms, and rarely in orthorhombic crystals, often showing pseudo-hexagonal twinning.

Compare with Aragonite (p. 118).

Large amounts are used in making the "red fire" of pyrotechny and in obtaining sugar from molasses, this being first precipitated as a Strontium compound.

281. CERUSSITE. $PbCO_3$. Hardness 3–3.5.

Lustre. — **Adamantine** or greasy to **silky.**
Color. — White, gray or brown.
Streak. — White.
Cleavage. — **None.**
Very brittle. **Conchoidal fracture.**
Transparent to nearly opaque.
S. G. — **6.5.**

B. B. — Decrepitates and fuses very easily, yielding a lead oxide sublimate and a globule of Pb.
Effervesces vigorously in hot concentrated or boiling dilute HCl.

Occurs in **silky, prismatic masses**; granular to compact massive; as disseminated grains, often in Limonite (p. 102); impure and earthy; rarely as orthorhombic crystals; fairly frequently as star-shaped twins; sometimes stalactitic or fibrous.

Compare with Anglesite (p. 250).

Frequently carries Silver and is a valuable ore of that metal, as well as of Lead, since it requires no preliminary roasting before smelting.

See Fig. 45.

ARAGONITE GROUP.

Members. — Aragonite, Witherite, Strontianite, Cerussite.

Composition. — Carbonates.

Crystallization. — Orthorhombic.

Additional. — All effervesce in some condition of HCl, are usually white, and are between 3 and 4 in hardness.

FIG. 44. — Aragonite, Cumberland England.

FIG. 45. — Cerussite, Leadville, Colorado.

HYDROUS CARBONATES.

288. MALACHITE. $CuCO_3 . CuO . H_2O$. Hardness 3.5–4.

Lustre. — **Silky** to dull. Crystals are sub-adamantine.
Color. — **Bright, emerald green.** Often nearly black on exposed surfaces.
Streak. — Green, paler than the color.
Cleavage. — **None.** Uneven fracture.
Translucent to opaque.

B. B. — On charcoal, decrepitates and fuses to a mass of metallic Cu, yielding Cu flame.
Effervesces vigorously in any condition of HCl.

Occurs massive or as crusts, with a botryoidal or stalactitic surface, a radiating structure, and a silky lustre; often compact fibrous and banded; also in indistinct, vertically striated, acicular monoclinic crystals; sometimes granular or earthy.

Usually associated with other Copper minerals as an alteration product, and with Limonite (p. 102).

Compare with Atacamite (p. 66), Olivenite (p. 236) and Conichalcite (p. 239).

An oxidized ore of Copper and the compact, banded varieties are cut and polished for use as an ornamental stone and in jewelry.

289. AZURITE. $2CuCO_3 . CuO . H_2O$. Hardness 3.5–4.

Lustre. — Vitreous.
Color. — **Dark blue to azure-blue.**
Streak. — Blue.
Brittle. Conchoidal fracture.
Transparent to opaque.

B. B. — On charcoal, decrepitates and fuses to a mass of metallic Cu, yielding Cu flame.
Effervesces vigorously in any condition of HCl.

Occurs massive, or in crusts with a velvety appearing and botryoidal surface, or as sharply crystallized but very complex, glassy monoclinic crystals, usually tabular in habit; also earthy.

Usually associated with other Copper minerals as an alteration product, and with Limonite (p. 102).

Compare Vivianite (p. 238).

An oxidized ore of Copper, is cut and polished for jewelry, and is manufactured into a poor grade of paint.

291. HYDROZINCITE. $3ZnCO_3 . 2H_2O$. **Hardness 2-2.5.**

Lustre. — Dull.
Color. — White, grayish or yellowish.
Streak. — White.
Conchoidal fracture.
Opaque.

B. B. — Infusible. **Effervesces vigorously in any condition of HCl.**

Occurs in **chalk-like or earthy masses**; as incrustations, sometimes with a concentric structure, and, rarely, stalactitic or pisolitic.

Usually associated with Smithsonite (p. 115), **or other Zn ores as an alteration product.**

Compare with Infusorial earth (p. 76), Chalk (p. 109) and Magnesite (p. 112).

Does not occur in quantities sufficiently large to allow of profitable working as an ore of Zinc.

296. NATRON. $Na_2CO_3 + 10H_2O$. **Hardness 1-1.5.**

Lustre. — Earthy.
Color. — White, yellow or gray.
Streak. — White.
Very brittle. Conchoidal fracture.
Tastes alkaline.
Opaque.

B. B. — On charcoal, fuses very easily and is absorbed by the charcoal.
Effervesces very vigorously in any condition of HCl.

Occurs in spongy masses or powdery crusts.

Compare with Calcareous Tufa (p. 110).

FELDSPAR SERIES.

Members. — Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Anorthite.

Composition. — Silicates of Aluminum and Potassium or Aluminum and Sodium and Calcium, one or both.

Crystallization. — Monoclinic or triclinic, the forms being very similar.

Additional.—All have a hardness of about 6, a vitreous lustre, two unequally good cleavages at an angle of exactly or nearly 90°, and are apt to be rather light colored.

The following table shows the principle upon which the subdivisions according to composition are based.

Acid Feldspars (Over 60% SiO_2)	Orthoclase Microcline Albite Oligoclase	Alkaline Feldspars [The alkalies (Na and K) prominent].
Basic Feldspars (Under 60% SiO_2)	Labradorite Anorthite	Lime Feldspars (Large amounts of CaO present.)

ANHYDROUS SILICATES.

FELDSPAR SERIES.

ORTHOCLASE GROUP.

313. ORTHOCLASE. $KAlSi_3O_8$. Hardness 6.

Lustre. — Vitreous to dull or **stony**.

Color. — **Flesh-red** to gray, yellow, white or colorless; rarely green.

Streak. — White.

Cleavage. — **Perfect basal and slightly less perfect clino-pinacoidal at angle of 90°.**

Brittle.

Transparent to opaque.

B. B. — Very thin splinters are fused with difficulty, giving K flame.

Occurs in cleavable or granular masses and in simple or twinned, monoclinic crystals; rarely crypto-crystalline or lamellar.

Varieties.

Crystals.

Both simple and twinned crystals invariably show a basal- and a clino-pinacoid with a prism, and a +ortho-dome is almost always present. Other forms are sometimes shown. They may be divided into the following three habits:

1. *Elongated* parallel to the *clino* axis. This type is the commonest.

2. *Elongated* parallel to the *vertical* axis.

3. *Tabular* parallel to the symmetry plane. This habit is rare.

In orienting crystals, remember that you must hold them so as to make a basal- and a clino-pinacoid and a prism prominent forms, though the prism is not as prominent as the others in the second habit.

The three types of twinning to which Orthoclase crystals are subject — described in the order of frequency of occurrence — are as follows:

1. *Carlsbad:* Usually interpenetration, but sometimes contact twins, twinning plane being the *ortho-pinacoid* and the plane of union, the clino-pinacoid.

2. *Baveno:* Contact twins, the planes of twinning and of union being a *clino-dome.*

3. *Mannebach:* Contact twins, the planes of twinning and of union being the *basal-pinacoid.*
   These three types of twinning affect the cleavage as follows:

Carlsbad: Breaks up the basal cleavage into right and left portions, one of which will flash light after turning the specimen around its ortho axis to a little over 60° from the flash of the other portion. The clino-pinacoidal cleavage is unaffected.

Baveno: Interchanges the two cleavages, bringing two perfect and two slightly less perfect cleavages together on opposite sides of the specimen.

Mannebach: Does not affect the cleavages.

ADULARIA.

Transparent, colorless, monoclinic crystals, showing a prism and basal-pinacoid as the main forms, thus **closely resembling rhombohedrons. Often coated with green Chlorite** (p. 210).

VALENCIANITE.

Translucent or opaque material, crystallized like Adularia.

SANADINE.

Glassy, transparent crystals or grains imbedded in relatively recent, acid volcanic rocks.

Compare with the other Feldspars, Rhodonite (p. 149) and Wernerite (p. 170).

The light colored varieties are used in the manufacture of glass and porcelain.

Ranks next to Quartz in frequency of occurrence.

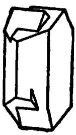

Fig. 46.
Carlsbad Twin.

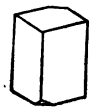

Fig. 47.
Adularia.

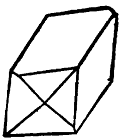

Fig. 48.
Baveno Twin.

315. MICROCLINE. $KAlSi_3O_8$. Hardness 6.

Lustre. — **Very brilliant vitreous on cleavage faces** to dull or stony.

Color. — White, yellow, gray, red, and **bright green,** called **AMAZON STONE.**

Streak. — White.

Cleavage. — **Perfect basal- and slightly less perfect brachy-pinacoidal at angle of about 89° 45′.**

Brittle.

Transparent to opaque.

B. B. — Very thin splinters are fused with difficulty, giving K flame.

Occurs in cleavable or granular masses and in simple or twinned crystals exactly like Orthoclase (p. 130) in habit and twinning excepting that they are triclinic.

A combination of the Albite and Pericline types of twinning — see under Albite (p. 135) for a description of these — often produces a **cross-hatched or grating-like appearance on the basal-pinacoid.**

Compare with the other Feldspars, Rhodonite (p. 149) and Wernerite (p. 170).

Much that is called Orthoclase is really Microcline, it being often impossible to distinguish between the two except optically.

Used for the same purposes as Orthoclase (p. 130). Amazon Stone is used in jewelry.

See Fig. 49.

ORTHOCLASE GROUP.

Members. — Orthoclase, Microcline.

Composition. — $KAlSi_3O_8$.

Crystallization. — Monoclinic and triclinic.

Additional. — These species are almost identical, the slight differences being noted on the preceding pages.

To distinguish the members of the Orthoclase Group from the minerals in the Plagioclase Group, which follows, remember that the former are very apt to weather to a reddish or reddish brown color, and to occur in rather compact, thickset crystals which often show the effect of Carlsbad twinning (p. 131) on the better cleavage. The frequent association with Quartz (p. 68) is often useful.

The above points are particularly applicable to the feldspars occurring in rocks.

Fig. 49. — Amazon Stone and Smoky Quartz on Albite, Florissant, Colorado.

PLAGIOCLASE GROUP.

316. ALBITE. $NaAlSi_3O_8$. Hardness 6–6.5.

Lustre. — Vitreous to pearly.

Color. — **White** or tinted light shades. Sometimes shows a delicate, bluish chatoyancy.

Streak. — White.

Cleavage. — **Perfect basal-, and slightly less perfect brachy-pinacoidal at angle of 86° 24′.**

Brittle.

Transparent to opaque.

B. B. — Small pieces fuse at under 4, giving Na flame.

Occurs in **masses made up of straight or curved laminae,** coarse to fine granular, and in small, tabular, triclinic crystals.

Almost invariably shows fine, albitic twinning striations on the better cleavage — basal — parallel to the poorer cleavage — brachy-pinacoidal. The basal-pinacoid is also thus striated.

Twinning.

Albite occurs twinned after the Carlsbad, Baveno and Mannebach laws (p. 131) but these are comparatively rare.

The common types are: —

1. *Albite* or *albitic:* Contact twins, usually polysynthetic, the planes of twinning and union being the *brachy-pinacoid,* thus giving rise to the striations mentioned above.

2. *Pericline:* Contact twins, usually polysynthetic, the planes of twinning and union being a possible *macro-dome,* sometimes producing striations on the brachy-pinacoid or poorer cleavage.

Varieties.

MOONSTONE.

Translucent, with a bluish chatoyancy on basal sections. Some Moonstone is Orthoclase or Oligoclase.

The color and mode of occurrence are usually perfectly distinctive.

See Fig. 49.

317. OLIGOCLASE. Ab_6An-Ab_3An.* **Hardness 6–7.**

Lustre. — Vitreous to pearly.
Color. — White, reddish, grayish or greenish.
Streak. — White.
Cleavage. — **Perfect basal- and slightly less perfect brachy-pinacoidal at angle of 86° 32′.**
Brittle.
Transparent to opaque.

B. B. — Fuses easily to a clear or enamel-like glass.

Occurs usually **cleavable massive**; sometimes compact, and, rarely, in simple or twinned, triclinic crystals like Albite (p. 135).

The crystals and cleavable massive material almost always show albitic twinning striations (p. 135).

Varieties.

SUNSTONE.

Shows internal yellowish or reddish fire-like reflections from Hematite (p. 83) scales.

Compare with the other Feldspars.

*$Na_2O . Al_2O_3 . 6SiO_2$ = Ab = Albite.
$CaO . Al_2O_3 . 2SiO_2$ = An = Anorthite.

319. LABRADORITE. AbAn–$AbAn_3$.* Hardness 6–7.

Lustre. — Vitreous to almost pearly.

Color. — **Dark gray,** brown, greenish or colorless. **Usually, a beautiful play of colors parallel to the brachy-pinacoid on cleavable varieties.**

Streak. — White.

Cleavage. — **Perfect basal- and slightly less perfect brachy-pinacoidal at angle of 86° 4′.**

Brittle.

Translucent to opaque.

B. B. — Fuses easily to a colorless glass.

Occurs granular or **cleavable massive,** or in triclinic crystals, usually very thin tabular; rarely cryptocrystalline.

The crystals and cleavable massive material almost always show albitic twinning striations (p. 135).

Compare with the other Feldspars.

*See p. 137.

320. ANORTHITE. $CaAl_2Si_2O_8$. Hardness 6–6.5.

Lustre. — Vitreous.
Color. — White, gray or **reddish.**
Streak. — White.
Cleavage. — **Perfect basal- and slightly less perfect brachy-pinacoidal at angle of 85° 50′.**
Brittle.
Transparent to opaque.

B. B. — Practically infusible.

Occurs in gray or pink cleavable, and **white or red granular masses;** also in simple or twinned triclinic crystals.

The crystals and cleavable massive material almost always show albitic twinning striations (p. 135).

Varieties.

INDIAN STONE.

White or red granular masses, resembling sandstone.

Compare with the other Feldspars. It is usually very difficult to indentify Anorthite unless it occurs in the Indian Stone habit.

PLAGIOCLASE GROUP.

Members. — Albite, Oligoclase, Labradorite, Anorthite.

Composition. — Silicates of Aluminum and Calcium and Sodium, one or both.

Crystallization. — Triclinic.

Additional. — These species often occur so similarly that to give their additional points of resemblance would involve giving most of their characteristics.

To distinguish the members of the Plagioclase Group from the minerals in the Orthoclase Group, which precedes the former, remember that the former are very apt to weather to a white or greenish color and to occur in decidedly tabular crystals, most sections of which will be "lath-shaped." The occurrence of striations on the better cleavage, parallel to the poorer, due to albitic twinning (p. 135), is very characteristic, and the rarity of association with Quartz (p. 68) is often a useful point to bear in mind.

The above features are particularly applicable to the Feldspars occurring in rocks.

321. LEUCITE. $KAl(SiO_3)_2$. Hardness 5.5–6.

Lustre. — Greasy vitreous to dull on the surface.
Color. — **Gray** to white.
Streak. — White.
No cleavage.
Brittle. Conchoidal fracture.
Translucent to opaque.

B. B. — Infusible.

Occurs as **grains** or *complete* **trapezohedral crystals** or **groups of crystals in volcanic rocks**; rarely granular massive.

Compare with Garnet (p. 163) and Analcite (p. 195).

Rock containing Leucite has long been used for millstones.

PYROXENE SERIES.

ORTHORHOMBIC PYROXENE GROUP.

323. Enstatite. $MgSiO_3$. Hardness 5.5.

Lustre. — Silky or pearly to metalloidal.
Color. — **Yellowish brown,** sometimes grayish or greenish.
Streak. — White.
Cleavage. — **Perfect brachy-pinacoidal parting in addition to a fair prismatic cleavage at an angle of 88° 16′.**
Brittle.
Translucent to opaque.

B. B. — Infusible.

Occurs lamellar or columnar-fibrous massive.

Variety.

BRONZITE.

Containing up to 14% Fe and often possessing a bronze-like lustre.

Compare with Hypersthene (p. 143) and Diallage (p. 145).

324. HYPERSTHENE. (Mg, Fe) SiO_3. Hardness 5–6.

Lustre. — Pearly to metalloidal.
Color. — **Dark green or brown to black.**
Streak. — Gray.
Cleavage. — **Perfect brachy-pinacoidal parting in addition to a fair prismatic cleavage at an angle of 88° 20′.**
Brittle.
Translucent to opaque.

B. B. — Fuses to a black magnetic mass.

Occurs in foliated or platy masses, which frequently show a peculiar schiller or glistening lustre due to minute tabular scales of doubtful character.

Compare with Enstatite (p. 142), Diallage (p. 145) and Titanite (p. 224).

MONOCLINIC PYROXENE GROUP.

288. PYROXENE. $\left.\begin{Bmatrix}Ca\\Mg\\Al\\Fe\\Mn\end{Bmatrix}\right. SiO_3$. Hardness 5–6.

Lustre. — Vitreous to dull.

Color. — Usually light to dark green of dull shades, or black; also white or brown.

Streak. — White to greenish.

Cleavage. — **Fair prismatic at angle of 87° 10′**; also sometimes a perfect basal parting due to twinning.

Brittle.

Transparent to opaque.

B. B. — Easily to difficultly fusible to a dark — sometimes magnetic — glass.

Occurs usually in **prismatic monoclinic crystals with a nearly square or octagonal cross-section,** sometimes twinned parallel to the ortho-pinacoid; also in foliated, coarse to fine granular or columnar masses and, rarely, fibrous.

Varieties.

Non-aluminous.

DIOPSIDE. CaMg.

Usually occurs as white or light green, rather glassy crystals.

HEDENBERGITE. CaFe.

Grayish green to almost black crystals or lamellar massive; also granular as **COCCOLITE.**

Aluminous.

DIALLAGE. CaMgFeAl.

Light green or brown material with a foliated structure due to the development of a **perfect ortho-pinacoidal parting.**

AUGITE. CaMgAlFe.

Black and very dark green or brown, short, prismatic crystals, often twinned.

Compare with Amphibole (p. 151), Wernerite (p. 170), Vesuvianite (p. 172) and Epidote (p. 181).

Some of the transparent varieties are sometimes cut as semi-precious gems.

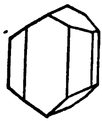

Fig. 50.
Augite.

327. SPODUMENE. $LiAl(SiO_3)_2$. Hardness 6.5–7.

Lustre. — Vitreous to **stony** or dull.
Color. — **Grayish white**; rarely green or pink; sometimes colorless.
Streak. — White.
Cleavage. — **Fair prismatic at angle of 87° and often a perfect ortho-pinacoidal parting, in addition.**
Brittle.
Transparent to opaque.

B. B. — Swells and fuses with intumescence to a clear or white glass, yielding Li flame when moistened with HCl.

Occurs cleavable massive and in monoclinic crystals, sometimes very large. The smaller crystals are often indistinctly crystallized and the vertical planes are usually striated and grooved.

The common development of the pinacoidal parting produces a platy structure which is quite characteristic.

Varieties.

HIDDENITE.

Slender, prismatic, **transparent, deep green** crystals.

KUNZITE.

Slender to stout, prismatic, **transparent, pink** crystals.

Compare the ordinary material with Orthoclase (p. 130) and Wernerite (p. 170).

Compare Hiddenite with Emerald (p. 157) and Tourmaline (p. 187).

Compare Kunzite with Tourmaline (Rubellite) (p. 187).

The transparent, colored varieties are valuable gems.

329. WOLLASTONITE. $CaSiO_3$. Hardness 4.5–5.

Lustre. — Vitreous to **silky.**
Color. — **White,** yellowish, reddish or brownish.
Streak. — White.
Cleavage. — **Fair basal- and ortho-pinacoidal at angle of 84° 30′.**
Brittle.
Translucent.

B. B. — Fuses fairly easily on the edges, giving Ca flame.

Occurs in compact, cleavable, or **bladed or columnar fibrous masses,** the fibres being usually parallel; rarely in monoclinic crystals.

Usually associated and mixed with Calcite.

Compare with Pectolite (p. 148), Tremolite (p. 151), Natrolite (p. 196) and Thomsonite (p. 198).

330. PECTOLITE. $HNaCa_2(SiO_3)_3$. Hardness 5.

Lustre. — **Silky** to almost vitreous.
Color. — **White** or grayish.
Streak. — White.
No cleavage apparent.
Brittle.
Nearly translucent to opaque.

B. B. — Fuses very easily to a white enamel. May give out light when broken in the dark.

Occurs as **sharp, radiating fibres or needles,** sometimes of great length; rarely in distinct monoclinic crystals.

The compact, radiating fibrous material is very tough and often quite soft, due to alteration.

Sometimes found massive, fine grained and very tough.

Often associated with Calcite (p. 107), **Prehnite** (p. 184), **Zeolites** (p. 191), **etc.**, in cavities in basic, eruptive rocks.

Compare with Wollastonite (p. 147), Tremolite (p. 151), Natrolite (p. 196) and Thomsonite (p. 198).

TRICLINIC PYROXENE GROUP.

335. RHODONITE. $MnSiO_3$. Hardness 5.5–6.5.

Lustre. — Vitreous to dull.

Color. — **Brownish red to rose-pink. Often coated with black MnO_2, if it has been exposed to the air.**

Streak. — White.

Cleavage. — **Fair prismatic at angle of 87° 32′, and poor basal.**

Brittle.

Transparent to opaque.

B. B. — Blackens and fuses easily.

Occurs cleavable to compactly granular massive, as disseminated grains, and as triclinic crystals which are usually rough with rounded edges.

Often associated with Calcite (p. 107), **Franklinite** (p. 90) **and Willemite** (p. 168); also with Tetrahedrite (p. 57) and Iron ores.

Varieties.

FOWLERITE.

Zinciferous, pink crystals or foliated masses.

Compare with Rhodochrosite (p. 114) and Orthoclase (p. 130).

Is used in making violet glass or glaze and is sometimes polished for inlaid work.

PYROXENE SERIES.

Members of the Orthorhombic Pyroxene Group — Enstatite, Hypersthene.

Members of the Monoclinic Pyroxene Group. — Pyroxene, Spodumene, Wollastonite, Pectolite.

Member of the Triclinic Pyroxene Group. — Rhodonite.

Composition. — Silicates of several bases, not including the alkalies.

Crystallization. — Orthorhombic, monoclinic and triclinic.

Additional. — All Pyroxenes have poor prismatic cleavage, at an angle of about 87°, and a nearly square or octagonal cross-section.

MONOCLINIC AMPHIBOLE GROUP.

338. AMPHIBOLE. $\left.\begin{cases} Mg \\ Ca \\ Al \\ Fe \\ Mn \\ Na_2 \\ K_2 \end{cases}\right\} SiO_3.$ Hardness 5–6.

Lustre. — Vitreous to silky.
Color. — White to black through gray and many shades of green.
Streak. — White or greenish.
Cleavage. — **Perfect prismatic at angle of 124° 11′.**
Brittle to flexible and tough.
Transparent to opaque.

B. B. — Easily to difficultly fusible to a dark — sometimes magnetic — glass.

Occurs usually in **prismatic monoclinic crystals with an acute rhombic or hexagonal cross-section; also fibrous;** sometimes columnar or coarse to fine granular; rarely lamellar. Sometimes crystals are twinned parallel to the ortho-pinacoid, making them appear to be hemimorphic orthorhombic.

Varieties.

Non-aluminous.

TREMOLITE. CaMg.

White to gray material, usually bladed and deeply striated or fibrous, often showing a silky lustre.

ACTINOLITE. CaMgFe.

Green, bladed, sometimes transparent crystals, usually very long and lying in great confusion as to direction.

NEPHRITE or **JADE**. CaMgFe.

Extremely tough, fine grained, compact material, varying in color from white to dark green.

ASBESTUS.

Any variety of Amphibole except those containing much Al, occurring in long, fine, flexible, easily separable fibres.

MOUNTAIN LEATHER and **CORK.**

Thin sheets and thicker pieces of interlaced fibres, often hydrous and white to gray or yellowish in color, and so light that they float on water.

URALITE.

Amphibole pseudomorphous after Pyroxene (p. 144).

Aluminous.

EDENITE. CaMgAl.

White to light green.

HORNBLENDE.

Dark green to **black**, often possessing a horn-like lustre. Crystals often appear to be rhombohedral hemihedral hexagonal.

Compare Tremolite with Wollastonite (p. 147) and Pectolite (p. 148).
Compare Actinolite with Cyanite (p. 177) and Tourmaline (p. 187).

Compare Asbestus with Crocidolite (p. 154) and Chrysotile (p. 214).

Compare Hornblende with Augite (p. 145) and Tourmaline (p. 187).

The many uses of Asbestus are well known.

Jade has been used since prehistoric times for the manufacture of weapons, it being the toughest known stone. In China and India it is still carved into ornaments, etc., and is highly valued.

See Fig. 52.

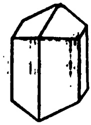

Fig. 51.
Hornblende.

341. CROCIDOLITE. $NaFe(SiO_3)_2 . FeSiO_3$. Hardness 4.

Lustre. — **Silky** to dull.
Color. — **Dark lavender-blue** or dark green.
Streak. — Like color.
Elastic.
Opaque.

B. B. — Fuses easily with intumescence to a black, magnetic glass, yielding Na flame.

Occurs in compact, **fibrous masses**, identically like Asbestus (p. 152) in structure.

Variety.

TIGER EYE or **CAT'S EYE.**

A hard, altered, siliceous variety, deep brown to light yellow in color, and possessing a highly chatoyant lustre.

Compare with Asbestus (p. 152) and Chrysotile (p. 214).

The Tiger Eye takes a high polish and is used, either in its natural color or artificially tinted, as an ornamental stone and in cheap jewelry.

See Fig. 53.

MONOCLINIC AMPHIBOLE GROUP.

Members. — Amphibole, Crocidolite.

Composition. — Silicates of several bases, including the alkalies.

Crystallization. — Monoclinic.

Additional. — All Amphiboles have a perfect prismatic cleavage at an angle of about 124°, and a rhombic or hexagonal cross-section.

Fig. 52. — Actinolite, Germany.

FIG. 53.—Crocidolite (showing silky lustre), South Griqualand, Africa.

344. BERYL. $Be_3Al_2(SiO_3)_6$. **Hardness 7.5-8.**

Lustre. — Vitreous.
Color. — **Shades of green and blue**; also yellow, white and colorless.
Streak. — White.
No cleavage. Conchoidal to uneven fracture.
Brittle.
Transparent to translucent.

B. B. — Infusible, but sometimes becomes cloudy.

Occurs crystalline or compact to granular massive, and in holohedral hexagonal crystals which are unstriated and often show a flat termination.

Varieties.

EMERALD.

Deep green, transparent material.

AQUAMARINE.

Beautiful greenish blue, transparent material. The name is also applied to stones that are blue without any tint of green.

Compare with Quartz (p. 68), Topaz (p. 174) and Tourmaline (p. 187).

The transparent material makes valuable gems.

See Fig. 54.

353. IOLITE. $H_2 \left\{ \begin{matrix} Mg \\ Fe \end{matrix} \right\}_4 Al_8Si_{10}O_{37}$. Hardness 7–7.5.

Lustre. — Vitreous to resinous.
Color. — **Light, dark, or smoky blue**; sometimes gray or yellow.
Streak. — White.
No cleavage. Subconchoidal fracture.
Brittle.
Transparent to translucent.
Dichroic. — Blue and yellow.

B. B. — Practically infusible but may become opaque.

Usually occurs crystalline massive or as imbedded grains looking much like blue Quartz (p. 68); also in short, prismatic orthorhombic crystals.

Compare with Quartz (p. 68) and Nephelite (p. 159).

Occasionally cut as an ornamental stone.

357. NEPHELITE. $(Na,K)_8Al_8Si_9O_{34}$. Hardness 5.5–6.

Lustre. — Vitreous to **greasy**.
Color. — **Greenish or bluish gray, reddish brown** and sometimes white or colorless when in crystals.
Streak. — White.
Cleavage. — **Hexagonal prismatic, good to absent.**
Brittle. Subconchoidal to conchoidal fracture.
Transparent to nearly opaque.

B. B. — Usually fuses easily to a colorless glass. Some of the massive varieties fuse with great difficulty, however.

Occurs cleavable or non-cleavable crystalline massive, as imbedded grains or short, hexagonal crystals usually showing only a prism and basal plane and yielding **square and six-sided cross-sections** perpendicular and parallel to the vertical axis. Sometimes occurs columnar massive.

Variety.

ELAEOLITE.

Massive, greasy lustered material.

Compare with Quartz (p. 68) and Iolite (p. 158).

360. CANCRINITE. $H_6Na_6Ca(NaCO_3)_2Al_8(SiO_4)_9$.
Hardness 5–6.

Lustre. — Sub-vitreous or greasy.
Color. — **Yellow**, white, gray, green, blue, and reddish.
Streak. — White.
Cleavage. — Good hexagonal prismatic.
Transparent to translucent.

B. B. — **Fuses very easily** with intumescence to a white blebby glass.
Effervesces vigorously in hot dilute HCl.

Occurs usually as imbedded grains or massive; rarely in prismatic hexagonal crystals.

The fusibility and acid test are completely determinative.

362. SODALITE. $Na_4 \left\{ \begin{matrix} Al \\ Cl \end{matrix} \right\} Al_2Si_3O_{12}$. **Hardness 5.5-6.**

Lustre. — Vitreous or slightly greasy.
Color. — **Blue,** gray, greenish, yellowish, white.
Streak. — White.
Cleavage. — **Poor to good dodecahedral.**
Brittle. Conchoidal to uneven fracture.
Transparent to translucent.

B. B. — Fine splinters are fairly easily fusible with intumescence, yielding a colorless glass.

Occurs massive and in disseminated grains; also in concentric nodular forms and, rarely, in holohedral isometric crystals.

Compare with Fluorite (p. 64).

369. ZUNYITE. $\left(Al\left\{\begin{matrix}OH\\F\\Cl\end{matrix}\right\}_2\right)_6 Al_2Si_3O_{12}$. Hardness 7.

Lustre. — Vitreous.
Color. — Colorless or white.
Streak. — White.
Cleavage. — Fair + and − tetrahedral.
Transparent to opaque.

B. B. — **Infusible,** but becomes opaque and looks like porcelain.

Occurs in **small, sharply crystallized tetrahedrons, imbedded in a white, earthy rock,** or mixed with Guitermanite, a sulphide of As and Pb.

The crystals are usually unmodified by any forms except sometimes a negative tetrahedron.

Compare with Boracite (p. 242).

GARNET GROUP.

370. GARNET. $\left.\begin{matrix}Ca\\Mg\\Fe\\Mn\end{matrix}\right\}_3 \left.\begin{matrix}Al\\Fe\\Mn\\Cr\\Ti\end{matrix}\right\}_2 (SiO_4)_3$. Hardness 6.5–7.5.

Lustre. — Vitreous to resinous.
Color. — **Red, brown, yellow,** white, black, green.
Streak. — White.
Cleavage. — **None usually apparent.** Rarely, dodecahedral.
Brittle. Uneven fracture.
Transparent to opaque.

B. B. — All varieties but Uvarovite fuse fairly easily; **always fusing to a darker color than they were originally,** some becoming magnetic.

Occurs usually **as more or less modified dodecahedral or trapezohedral isometric crystals** imbedded in mica or other schists, the faces being often striated; also as druses, granular, lamellar or compact massive, and as rounded grains in alluvial material.

Varieties.

GROSSULARITE or **ESSONITE.** CaAl.

White, yellowish, yellowish brown, pale green, pale rose-red.

PYROPE. MgAl.

Deep red to nearly black. Often transparent and is then a semi-precious gem.

ALMANDITE. FeAl.

Deep red, transparent, to brownish red or black, translucent to opaque. Includes both semi-precious and common Garnet.

SPESSARTITE. MnAl.

Dark purplish red to brownish red.

ANDRADITE. CaFe.

Many colors but lacking transparency and including much of the common Garnet.

UVAROVITE. CaCr.

Emerald-green, infusible crystals.

Compare the massive material with massive Vesuvianite (p. 172), Chondrodite (p. 185) and Tourmaline (p. 187).

Garnet is a very important abrasive substance and many of the transparent varieties make beautiful, semi-precious gems.

See Fig. 55.

371. SCHORLOMITE. $3CaO.\left\{\begin{matrix}Fe\\Ti\end{matrix}\right\}_2O_3.3\left\{\begin{matrix}Si\\Ti\end{matrix}\right\}O_2.$

Hardness 7–7.5.

Lustre. — Vitreous.
Color. — **Black, often iridescently tarnished.**
Streak. — **Grayish black.**
Conchoidal fracture. Brittle.
Translucent to opaque.

B. B. — Fuses fairly easily and quietly to a black magnetic glass.

Occurs usually massive.

Compare with Allanite (p. 182) and Samarskite (p. 227).

GARNET GROUP.

Members. — Garnet, Schorlomite.

Composition. — Silicates of several bases.

Crystallization. — Holohedral isometric.

Additional. — Both have a vitreous lustre, a hardness of about 7, fuse in a similar manner, and are without cleavage.

Fig. 54. — Beryl, Chaffee County, Colorado.

Fig. 55. — Garnet (weight, 8 lbs.) Salida, Colorado.

376. CHRYSOLITE. $\left\{\begin{matrix}Mg\\Fe\end{matrix}\right\}_2 SiO_4$ Hardness 6.5–7.

Lustre. — Vitreous.

Color. — **Bottle-green.** By oxidation of the Fe becomes very dark green or reddish brown. Yellow-green when fine grained.

Streak. — White or yellowish.

No cleavage. Conchoidal fracture. Brittle.

Transparent to opaque, when the Fe has oxidized.

B. B. — Usually infusible, but loses color.

Occurs in coarse to fine **granular masses**, as disseminated grains, and, rarely, as rectangular orthorhombic crystals or as sand.

Variety.

PERIDOT or **EVENING EMERALD.**

Yellowish green transparent material which, when cut and polished, forms a semi-precious gem.

Compare with Willemite (p. 168) and Epidote (p. 181).

Large grains or crystals without flaws are valuable gem material.

381. WILLEMITE. Zn_2SiO_4. Hardness 5.5.

Lustre. — Weak vitreous or resinous to dull.

Color. — Green or yellow when pure, but often brown or flesh colored.

Streak. — White or grayish.

Cleavage. — Poor hexagonal prismatic to none.

Brittle. Conchoidal to uneven fracture.

Transparent to opaque.

B. B. — Glows and fuses with difficulty on the edges to a white enamel. On charcoal, gives sublimate of zinc oxide after long heating.

Usually occurs **granular** or in rather **thick, prismatic, rhombohedral hemihedral hexagonal crystals**; rarely massive. The crystals are rarely long and slender.

Often associated with Zincite (p. 80), **Franklinite** (p. 90), **Calcite** (p. 107), and **Rhodonite** (p. 149).

Variety.

TROOSTITE.

Thick prismatic, gray or flesh colored crystals.

Compare with Rhodonite (p. 149), Wernerite (p. 168) and Apatite (p. 230).

A valuable ore of Zinc.

SCAPOLITE GROUP.

386. MEIONITE. $Ca_4Al_6Si_6O_{25}$. Hardness 5.5–6.

Lustre. — Vitreous.
Color. — **Colorless or milky white.**
Streak. — White.
Cleavage. — Prismatic at angle of 90°, good to absent.
Brittle. Conchoidal fracture.
Transparent to translucent.

B. B. — Fuses easily with intumescence to a white blebby glass.

Occurs in pyramidal hemihedral **tetragonal crystals** which are usually apparently holohedral; also in crystalline grains and massive.

Compare with Pyroxene (p. 144) and Wernerite (p. 170).

387. WERNERITE. $Na_2Ca_2Al_6Si_9O_4$ Hardness 5–6.

Lustre. — Vitreous to dull, the latter being often confined to the outside.

Color. — White, gray, lilac, greenish and other light tints.

Streak. — White.

Cleavage. — **Poor to good, parallel to direct and indirect tetragonal prisms.**

Brittle.

Translucent to opaque.

B. B. — Fuses easily with intumescence to a white blebby glass.

Occurs as **large, dull tetragonal crystals** that are really pyramidal hemihedral but are usually apparently holohedral; also cleavable, columnar or granular massive.

Cleavage or crystal surface often shows a characteristic **fibrous appearance.**

Compare with Orthoclase (p. 130), Spodumene (p. 146). and Meionite (p. 169).

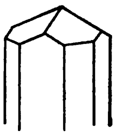

FIG. 56.

SCAPOLITE GROUP.

Members. — Meionite, Wernerite.

Composition. — Calcium Aluminum silicates, with or without Sodium.

Crystallization. — Pyramidal hemihedral tetragonal.

Additional. — Both may have a vitreous lustre, a hardness of between 5 and 6 and both fuse in a similar manner.

393. VESUVIANITE. $H_4Ca_{12}\left\{\begin{matrix}Al\\Fe\end{matrix}\right\}_6Si_{10}O_{43}$. Hardness 6.5.

Lustre. — Vitreous to resinous.
Color. — **Brown, green** and, rarely, yellow or pale blue.
Streak. — White.
Cleavage. — **None.**
Brittle. Uneven to subconchoidal fracture.
Nearly transparent to opaque.

B. B. — Fuses easily with intumescence to a **green or brown glass.**

Occurs usually in **pyramidal tetragonal crystals**; or as **deeply striated or grooved crystalline aggregates**; also radiating, columnar, granular and compact massive.

Compare massive material with Garnet (p. 163) and Tourmaline (p. 187).

394. ZIRCON. $ZrSiO_4$. Hardness 7.5.

Lustre. — Adamantine to vitreous.
Color. — **Usually gray or brown when opaque, and red when transparent**; also yellow and green.
Streak. — White.
Cleavage. — None.
Brittle. Conchoidal fracture.
Opaque to transparent.

B. B. — Infusible, but **entirely loses color.**

Occurs usually as **small, sharply cut tetragonal crystals with a prism and rather flat pyramid of the same order as the main forms**; also as highly modified crystals, irregular forms, and in grains.

Varieties.

HYACINTH or **JACINTH.**

Transparent, red, orange, or brown gem material.

JARGON.

Transparent, white or smoky material sometimes used as a substitute for Diamond (p. 1).

The appearance is usually distinctive.

A semi-precious gem. Zirconium oxide may be used as a substitute for lime in the oxyhydrogen lantern.

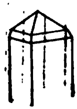

Fig. 57.

TOPAZ GROUP.

397. TOPAZ. $(Al\left\{\begin{matrix}O\\F_2\end{matrix}\right\})AlSiO_4$. **Hardness 8.**

Lustre. — **High vitreous** to adamantine.

Color. — **White, yellow, yellowish brown** or light tints of blue, green or pink.

Streak. — White.

Cleavage. — **Basal, very perfect** to fair in some massive varieties.

Brittle.

Transparent to translucent.

B. B. — Infusible, but some yellow varieties become pink or reddish.

Occurs in **fine, prismatic orthorhombic crystals** which are often highly modified; also cleavable massive and as water-worn pebbles in alluvial material; rarely granular.

Sometimes the crystals are rough and almost opaque due to inclusions of the gangue-rock.

The colored varieties often lose their color when exposed to the light.

Compare with Quartz (p. 68), Beryl (p. 157) and Tourmaline (p. 187).

Is used to some extent as an abrasive and the transparent varieties are cut for gems, the white material being a substitute for Diamond (p. 1).

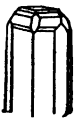

FIG. 58.

398. ANDALUSITE. Al_2SiO_5. Hardness 7.5.

Lustre. — Vitreous, often weak.
Color. — Usually **brownish red** or pearl gray; sometimes whitish, violet, and dull green.
Streak. — White.
Cleavage. — Poor to good prismatic at angle of 89° 12′.
Brittle to tough.
Transparent to opaque. Usually translucent.

B. B. — Infusible.

Occurs in **coarse, nearly square, prismatic orthorhombic crystals**, or tough, indistinctly columnar or granular massive.

Variety.

CHIASTOLITE or **MACLE.**

An impure, soft, dull, hydrated variety occurring in **rounded prisms which exhibit on cross-section a white cross or square on a dark ground**, caused by the inclusion of organic impurities during the crystallization process.

Compare with Elaeolite (p. 159) and Wernerite (p. 170).

FIG. 59.
Sections of Chiastolite.

309. SILLIMANITE. Al_2SiO_5. Hardness 6–7.

Lustre. — Vitreous, high to dull.

Color. — Brown, gray, and sometimes greenish.

Streak. — White.

Cleavage. — Perfect brachy-pinacoidal, often indistinct on fibrous varieties.

Usually very tough.

Transparent to translucent.

B. B. — Infusible.

Occurs in very long and slender, indistinctly terminated orthorhombic crystals; also columnar or fibrous massive, being sometimes very compact.

Compare with Tremolite (p. 151), Andalusite (p. 175) and Cyanite (p. 177).

The densely compact, fibrous variety was much used for making implements and weapons during the "Stone Age," being almost as tough as Jade (p. 152).

400. CYANITE. Al_2SiO_5. **Hardness 4-7.** (See below.)

Lustre. — Vitreous to **pearly on cleavage face.**
Color. — **White or light blue**; sometimes gray, green or black. **The white material is very often streaked with blue.**
Cleavage. — **Perfect macro-pinacoidal**, a fair brachy-pinacoidal at an angle of 73° 56′ with the first, and a basal parting at an angle of 78° 30′ with the first and at an angle of 86° 45′ with the second. The last two often appear as cracks on the perfect cleavage.
Brittle.
Transparent to translucent.

B. B. — Infusible.

Occurs in **long, bladed triclinic crystals**; sometimes fibrous.

The hardness is 4-5 on the cleavage face parallel to the direction of elongation and 6-7 perpendicular to this direction.

The appearance and hardness test are usually perfectly distinctive.

The transparent varieties are sometimes used as gems, the blue material resembling Sapphire (p. 82).

See Fig. 60.

TOPAZ GROUP.

Members. — Topaz, Andalusite, Sillimanite, Cyanite.

Composition. — All have the formula Al_2SiO_5, but Topaz contains some Fluorine.

Crystallization. — Orthorhombic and triclinic.

Additional. — Only Cyanite can be scratched with a knife, and that is possible in only one direction on this mineral.
All may have a vitreous lustre and are infusible.

FIG. 60. — Cyanite, St. Gothard Region, Switzerland.

401. DATOLITE. $Ca(BOH)SiO_4$. Hardness 5–5.5.

Lustre. — Vitreous to dull.

Color. — **Colorless,** white or greenish when in crystals; greenish, reddish or yellowish when massive.

Streak. — White.

Cleavage. — **None.**

Brittle. Conchoidal to uneven fracture.

Transparent to opaque.

B. B. — Fuses very easily with intumescence to a clear glass, yielding B flame.

Occurs as **groups of very complex, glassy monoclinic crystals** lining cavities in "Trap" rocks; also **crypto-crystalline or flint-like**; rarely botryoidal with a radiating structure.

The lack of cleavage or the hardness will serve to distinguish this from all similar species.

406. ZOISITE. $HCa_2Al_3Si_3O_{13}$. Hardness 6–6.5.

Lustre. — Vitreous.
Color. — **Gray or pink**; sometimes brown or green.
Streak. — White.
Cleavage. — **Perfect brachy-pinacoidal.**
Brittle.
Transparent to translucent.

B. B. — Swells and fuses to a white, blebby glass.

Occurs in deeply vertically striated or furrowed orthorhombic crystals which rarely show distinct terminations; also compact to **cleavable, columnar massive**; sometimes almost fibrous or cryptocrystalline.

Varieties.

THULITE.

Pink in color and often almost fibrous in structure.

SAUSSURITE.

A dull, tough, compact, cryptocrystalline mixture of several minerals, being principally Zoisite with more or less Albite (p. 135), Epidote (p. 181), Calcite (p. 107), Garnet (p. 163), Tremolite (p. 151), Chlorite (p. 210), etc. It is gray or greenish in color and results from the alteration of Plagioclases in basic, eruptive rocks.

Compare with Tremolite (p. 151).

407. EPIDOTE. $HCa_2\begin{Bmatrix}Al\\Fe\end{Bmatrix}_3 Si_3O_{13}$. Hardness 6–7.

Lustre. — Vitreous to dull.

Color. — **Pistachio-green** when massive and **dark green** to greenish black or brown when in crystals; very rarely red, gray or colorless.

Streak. — White.

Cleavage. — **Perfect basal.**

Brittle.

Transparent to opaque.

Dichroic. — Brown and green.

B. B. — Fuses fairly easily with intumescence to a dark brown or black glass which is sometimes magnetic.

Occurs in **monoclinic crystals, often long, brilliant, deeply striated** and elongated in the direction of the ortho-axis. The crystals are frequently so twinned (parallel to the ortho-pinacoid) as to appear orthorhombic. The mineral also occurs **coarse cleavable to fine granular** and, rarely, fibrous.

Compare with Chrysolite (p. 167) and Willemite (p.168).

409. ALLANITE. $H\begin{Bmatrix}Ca\\Fe\end{Bmatrix}_2\begin{Bmatrix}Al\\Fe\\Ce\\Di\\Ca\\Y\\Er\end{Bmatrix}_3 Si_3O_{13}.$ **Hardness 5.5–6.**

Lustre. — Submetallic to pitch-like.
Color. — Brown to black.
Streak. — Nearly white; also gray and tinted.
Cleavage. — None. Uneven fracture.
Brittle.
Opaque.

B. B. — Swells and fuses easily to a dark, blebby, magnetic glass.

Occurs in veins and massive, or as round to angular disseminated grains; also in tabular to acicular monoclinic crystals.

Compare with Schorlomite (p. 165) and Samarskite (p. 227).

410. AXINITE. $H\left\{\begin{matrix}Ca\\Mn\\Fe\\Mg\end{matrix}\right\}_3 BAl_2(SiO_4)_4$. Hardness 6.5–7.

Lustre. — High vitreous.

Color. — **Clove-brown,** dark blue, or gray; sometimes yellow or greenish.

Streak. — White.

Brittle. Conchoidal fracture.

Transparent to sub-translucent.

Pleochroic. — Green, blue and brown.

B. B. — Fuses very easily with intumescence to a dark green or black glass, yielding B flame during fusion.

Occurs usually in **acute-edged, tabular triclinic crystals,** often coated with Chlorite (p. 210); rarely massive, lamellar or granular.

Compare with Titanite (p. 224).

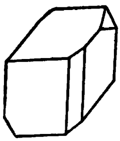

FIG. 61.

411. PREHNITE. $H_2Ca_2Al_2Si_3O_{12}$. Hardness 6–6.5.

Lustre. — Vitreous.
Color. — **Light green** to grayish.
Streak. — White.
Cleavage. — Good basal.
Brittle.
Translucent.

B. B. — Fuses very easily to a blebby, enamel-like glass.

Occurs in **botryoidal or globular groups of tabular orthorhombic crystals**, united by their basal-pinacoids and **forming a crust or lining to cavities** in "Trap" rocks. These groups are often rounded or barrel-shaped. Rarely found compact granular.

Often associated with Zeolites (p. 191), Datolite (p. 179) and Calcite (p. 107) or Aragonite (p. 118).

Compare with Chalcedony (p. 71), Smithsonite (p. 115) and Calamine (p. 186).

Prehnite takes a high polish and is used for inlaid work and for making ornaments. It has been used occasionally as a gem.

415. CHONDRODITE. $H_2\left\{\begin{matrix}Mg\\Fe\end{matrix}\right\}_{19}Si_8O_{34}F_4$. Hardness 6–6.5.

Lustre. — Vitreous.
Color. — **Garnet-red,** reddish brown, yellowish brown or yellow.
Streak. — White.
Cleavage. — Practically none. Uneven fracture.
Brittle.
Transparent to translucent.

B. B. — **Infusible,** but sometimes blackens and then turns white.

Occurs in **very complex monoclinic crystals,** compact massive, and as disseminated grains.

Usually found in crystalline limestones or associated with Serpentine (p. 214) — formed by alteration of the Chondrodite —, Magnetite (p. 89) and Chlorite (p. 210).

Compare with Garnet (p. 163) and Tourmaline (p. 187).

423. CALAMINE. $H_2Zn_2SiO_5$. **Hardness 4.5-5.**

Lustre. — Vitreous to nearly pearly.
Color. — Colorless or white, often tinted with yellow or brown; rarely bluish or greenish.
Streak. — White.
Cleavage. — Good prismatic at angle of 103° 51′.
Brittle.
Transparent to opaque.

B. B. — Infusible.

Usually occurs as a **drusy coating of more or less transparent, hemimorphic orthorhombic crystals, usually united to form ridges or cockscombs showing transverse grooves;** also stalactitic, botryoidal, granular massive, and as a constituent of clays.

The hardness and manner of occurrence are usually distinctive, though it sometimes closely resembles Smithsonite (p. 115) and, less closely, Prehnite (p. 184).

It is a fairly common and valuable ore of Zinc, requiring no roasting but sometimes being calcined in kilns to drive off water.

Fig. 62.

423. TOURMALINE. $\left\{\begin{matrix}Na\\Li\\K\end{matrix}\right\}_6\left\{\begin{matrix}Mg\\Fe\\Ca\end{matrix}\right\}_3\left\{\begin{matrix}Al\\Cr\\Fe\end{matrix}\right\}_2 B_2SiO_5$.

Hardness 7–7.5.

Lustre. — Vitreous to resinous.

Color. — **Black, brown,** brownish red, red, green and, rarely, blue; sometimes **the color of the interior differs from that of the exterior or the two ends of a crystal are of different colors.**

Streak. — White.

Cleavage. — **None.**

Very brittle. Uneven to sub-conchoidal fracture.

Transparent to opaque.

B. B. — **Usually fuses,** either easily or with difficulty, **to a glass,** sometimes blebby and always **lighter in color than the unfused mineral.**

Occurs in prismatic or, rarely, flattened, indistinct or sharply crystallized **hemimorphic rhombohedral hemihedral hexagonal crystals, which usually show a spherical triangle in cross-section and are often vertically striated.**

The forms common on crystals are a trigonal prism of the first order, a second order prism, + R and − ½ R, rarer forms being other rhombohedrons, scalenohedrons, basal pinacoid, ditrigonal prisms, and a − trigonal prism of the first order.

Occurs also compact massive and coarse to fine columnar; parallel or radiating.

Varieties.

The varieties are based on composition.

Alkali Tourmaline.

Color red, green or, rarely, colorless.

Iron Tourmaline.

Color usually black.

Magnesium Tourmaline.

Color redd'sh brown to brownish black or, rarely, colorless.

The manner of occurrence or the B. B. reactions are distinctive, though Tourmaline often closely resembles Garnet (p. 163), Vesuvianite (p. 172) or Chondrodite (p. 185) when massive, and Actinolite (p. 151), Hornblende (p. 152) or Beryl (p. 157) when crystallized.

The colored, transparent varieties are cut and rank as semi-precious gems.

See Fig. 66.

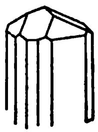

FIG. 63.

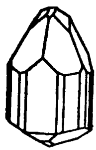

FIG. 64.

428. STAUROLITE. $H_4 \left\{ \begin{matrix} Fe \\ Mg \end{matrix} \right\}_6 \left\{ \begin{matrix} Al \\ Fe \end{matrix} \right\}_{24} Si_{11}O_{66}$.

Hardness 7–7.5.

Lustre. — Vitreous to **dull.**
Color. — **Yellowish or reddish brown.**
Streak. — White or gray.
Cleavage. — **None.**
Brittle. Uneven to sub-conchoidal fracture.
Translucent to **opaque.**

B. B. — Usually infusible. A rare magnesian variety fuses easily to a black, magnetic glass.

Occurs always as **simple or twinned orthorhombic crystals,** the twins being cruciform and crossing at angles of 90° or 120°.

The forms present are usually a wide angled prism; brachy-pinacoid, basal-pinacoid, and macro-dome. By suppression of opposite dome faces, the crystals often appear to be monoclinic.

Usually found imbedded in mica or other schists.

The appearance is distinctive.

See Fig. 67.

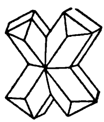

FIG 65.
Cross Twins.

Fig. 66.—Tourmaline, California.

Fig. 67.—Staurolite, St. Gothard Region, Switzerland.

HYDROUS SILICATES.

ZEOLITE DIVISION.

435. APOPHYLLITE. $H_7KCa_4(SiO_3)_8 + 4\frac{1}{2} H_2O$.
Hardness 4.5–5.

Lustre. — Vitreous. **Pearly on cleavage face.**

Color. — **Colorless or white**; sometimes pink and, rarely, greenish or yellowish.

Streak. — White.

Cleavage. — **Perfect basal.**

Brittle.

Transparent to nearly opaque.

B B. — Exfoliates and fuses very easily to a white blebby enamel, yielding K flame.

Occurs in **distinct prismatic, cubical, or tabular tetragonal crystals.** The prismatic habit usually shows a prism and pyramid of different orders. In all habits the **prism is vertically striated.** Other forms may be present, the basal pinacoid being prominent on the second and third habits and often appearing as a cleavage face on the first habit. Found also massive and lamellar; rarely radiated concentric.

Compare with Chabazite (p. 194).

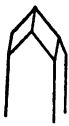

FIG. 68.

438. HEULANDITE. $H_4CaAl_2Si_6O_{18} + 3H_2O$. Hardness 3.5–4.

Lustre. — Vitreous. **Pearly on cleavage face.**
Color. — **White,** yellow, brown, red.
Streak. — White.
Cleavage. — **Perfect clino-pinacoidal.**
Brittle.
Transparent to translucent.

B. B. — Exfoliates and fuses very easily to a white enamel.

Occurs in **monoclinic crystals** and, rarely, globular or granular.

Crystals are often made up of many individuals flattened parallel to the clino-pinacoid and attached in nearly parallel position.

The appearance of **a cleavage face is unsymmetrical, as shown below.**

Compare with Stilbite (p. 193) and Gypsum (p. 225).

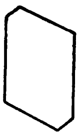

FIG. 69.
Cleavage Face.

443. **STILBITE.** $H_4\left\{\begin{matrix}Ca\\Na_2\end{matrix}\right\}Al_2Si_6O_{18} + 4H_2O$. Hardness 3.5–4.

Lustre. — Vitreous. **Pearly on cleavage face.**
Color. — **White, yellow,** red, brown.
Streak. — White.
Cleavage. — **Perfect clino-pinacoidal.**
Brittle.
Transparent to translucent.

B. B. — Exfoliates and fuses very easily to a white enamel.

Occurs in **single, usually tabular, pseudo-orthorhombic monoclinic crystals or united parallel to the clino-pinacoid into sheaf-like bunches.** Crystals are always complex twins. Found also radiated, globular, and lamellar or columnar.

The appearance of **a cleavage face is symmetrical, as shown below.**

Compare with Heulandite (p. 192) and Gypsum (p. 255).

See Fig. 71.

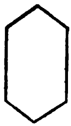

Fig. 70.
Cleavage Face.

447. CHABAZITE. $\left\{\begin{matrix}Ca\\Na_2\\K_2\end{matrix}\right\}Al_2Si_4O_{12}+6H_2O$. Hardness 4–5.

Lustre. — Vitreous.
Color. — **Light red, white,** yellow, colorless.
Streak. — White.
Cleavage. — Poor rhombohedral.
Brittle.
Transparent to translucent.

B. B. — Intumesces and fuses easily to a white blebby glass.

Occurs usually **in unmodified rhombohedrons, closely resembling cubes** (R to R being 85° 14′), **often striated parallel to the edges.** Interpenetration or contact twins with the basal-pinacoid as twinning plane are not uncommon. More or less modified crystals and twinning parallel to the rhombohedron are rare.

The first material to deposit in cavities in basic lavas.

Varieties.

PHACOLITE.

Colorless crystals which show contact twinning parallel to the basal pinacoid and are usually rather highly modified so as to be rather lenticular in form.

Compare with Calcite (p. 107) and Apophylite (p. 191).

See Fig. 72.

450. ANALCITE. $NaAlSi_2O_6 + H_2O$. Hardness 5–5.5.

Lustre. — Vitreous.
Color. — **White,** colorless; rarely greenish or reddish.
Streak. — White.
Cleavage. — Practically none.
Brittle. Sub-conchoidal fracture.
Transparent to opaque.

B. B. — Fuses easily and quietly to a colorless glass.

Occurs usually as **unmodified isometric trapezohedrons,** commonly forming a rather drusy surface and only very **rarely bounded on all sides by faces** like Leucite (p. 141).

Sometimes modified by the trisoctohedron, and very rarely cubical in habit.

Also found granular to compact massive.

Usually **forms after, and on top of Thomsonite** (p. 198) **in cavities in basic lavas.**

Compare crystals with Leucite (p. 141) and Garnet (p. 163).

Compare massive material with Quartz (p. 68).

See Fig. 73.

453. NATROLITE. $Na_2Al_2Si_3O_{10} + 2H_2O$.

Hardness 5–5.5.

Lustre. — Vitreous.

Color. — **Colorless, white**; rarely yellow or reddish.

Streak. — White.

Cleavage. — Good prismatic at angle of 88° 45′.

Brittle.

Transparent to translucent.

B. B. — Fuses very easily and quietly to a colorless glass.

Occurs in **slender orthorhombic crystals showing a nearly square prism, a flat pyramid and often a brachy-pinacoid.** These are usually interlacing or divergent. Also found fibrous, and, rarely, massive.

Compare with Pectolite (p. 148), Mesolite (p. 197) and Thomsonite (p. 198).

455. MESOLITE. $\left\{ \begin{matrix} Ca \\ Na_2 \end{matrix} \right\} Al_2Si_3O_{10} + 3H_2O$. Hardness 5.

Lustre. — **More or less silky** to vitreous.
Color. — **White,** colorless, grayish, yellowish.
Streak. — White.
Cleavage. — Good prismatic at angle of 88° but this is only apparent on crystals.
Crystals are brittle, fibrous material is flexible, and the cryptocrystalline variety is tough.
Transparent to opaque.

B. B. — Becomes opaque, swells into vermicular forms, and fuses easily to a blebby enamel.

Occurs **in very delicate, cotton-like, fibrous, divergent groups or tufts or as interlaced fibres,** being usually the **last substance to form in cavities in basic lavas.**

Also, but rarely, found in slender, prismatic monoclinic or triclinic crystals; as silky fibrous or columnar nodules or masses; stalactitic with a radiating fibrous structure; massive; porcelain-like cryptocrystalline.

Compare with Pectolite (p. 148), Natrolite (p. 196) and Thomsonite (p. 198).

See Fig. 74.

456. THOMSONITE. $\left\{ \begin{matrix} Na_2 \\ Ca \end{matrix} \right\} Al_2Si_2O_8 + 2\frac{1}{2}H_2O$.

Hardness 5–5.5.

Lustre. — Vitreous.
Color. — **Snow-white**, reddish, greenish, brown.
Streak. — White.
Cleavage. — **Perfect brachy-pinacoidal.**
Rather brittle.
Transparent to nearly opaque.

B. B. — Fuses easily with intumescence to a white enamel.

Occurs in **hard, botryoidal crusts, globular or stalactitic with a radiating structure**; also in **radiating, globular aggregates of platy orthorhombic crystals**; sometimes compact, filling cavities in igneous rock. The last variety has a structure which radiates from one or several centers and is mottled or banded with red and green. Weathering washes these amygdules out of the rock and they are then found in the form of pebbles.

Compare the crystalline material with Pectolite (p. 148) and Natrolite (p. 196).
Compare the amygdaloidal variety with Agate (p. 73).

The amygdaloidal variety is a semi-precious stone.

See Figs. 73, 74 and 75.

ZEOLITE DIVISION.

Members. — Apophylite, Heulandite, Stilbite, Chabazite, Analcite, Natrolite, Mesolite, Thomsonite.

Composition. — Hydrous silicates of Aluminum and one or more of the elements Calcium, Sodium and Potassium.

Crystallization. — All systems.

Additional. — All fuse easily and most of them intumesce or exfoliate. All are under six in hardness and are apt to be white.

Zeolites are all formed by the alteration of the Plagioclases in basic eruptive rocks, occurring in cavities in the same.

The lining of a cavity — the first mineral formed — is often Chabazite. On this occurs a layer of Thomsonite, then, often, some Analcite or other species.

FIG. 71.—Stilbite, New Jersey.

FIG. 72.—Chabazite, Nova Scotia.

FIG. 73.—Analcite on Thomsonite,
North Table Mountain, Golden, Colorado.

Fig. 74.—Mesolite on Thomsonite, North Table Mountain, Golden, Colorado.

Fig. 75.—Thomsonite, North Table Mountain, Golden, Colorado.

MICA DIVISION.

MUSCOVITE GROUP.

458. MUSCOVITE. $H_2KAl_3Si_3O_{12}$. Hardness 2–2.5.

Lustre. — Vitreous to **pearly on cleavage face.**

Color. — **Colorless or light tints** of nearly any color, particularly gray, brown or green.

Streak. — White.

Cleavage. — **Perfect basal.**

Cleavage lamellae are flexible, elastic, and transparent.

Usually very tough.

B. B. — Practically infusible.

Occurs usually in **disseminated scales, plates or scaly massive**; also in masses of coarse to fine scales grouped in star-like, globular or plume-like forms; sometimes cryptocrystalline. Also found in tabular, horizontally striated monoclinic crystals which very closely resemble steep rhombohedrons and a basal plane.

Compare with Brucite (p. 105), Talc (p. 217) and Gypsum (p. 255).

Large plates are in demand for putting in stove doors, etc. Also much used as insulation in electrical apparatus and for spangling papers and fabrics.

460. LEPIDOLITE. $KLi\left\{\begin{matrix}Al(OH)_2\\ AlF_2\end{matrix}\right\}Al(SiO_3)_3$.

Hardness 2.5–4.

Lustre. — Pearly.

Color. — **Usually pink or lilac**; more rarely violet, gray, yellowish or white.

Streak. — White.

Cleavage. — **Perfect basal.**

Cleavage lamellae are flexible and elastic.

Sectile.

Translucent.

B. B. — Fuses easily with intumescence to a white or grayish glass, yielding Li flame at the moment of fusion.

Occurs usually **coarse to fine scaly-granular massive**; sometimes in plates or in short, pseudo-hexagonal, monoclinic, prismatic crystals.

Compare with Diaspore (p. 99).

462. BIOTITE. $\left\{\begin{matrix}H\\K\end{matrix}\right\}_2\left\{\begin{matrix}Mg\\Fe\end{matrix}\right\}_2Al_2Si_3O_{12}$. Hardness 2.5–3.

Lustre.—**Pearly on cleavage face;** otherwise vitreous; submetallic when black.

Color.—**Black or dark brown;** rarely dark green.

Streak.—White.

Cleavage.—**Perfect basal.**

Very thin cleavage lamellae are flexible and elastic excepting when hydrated, being then somewhat brittle.

Sectile.

Transparent to opaque.

B. B.—Whitens and fuses on thin edges.

Occurs like Muscovite (p. 202), q. v.

462A. PHLOGOPITE. $\left\{\begin{matrix} H \\ K \\ MgF \end{matrix}\right\}_3 Mg_3Al(SiO_4)_3.$
Hardness 2.5–3.

Lustre. — **Bronzy to** pearly on cleavage face.
Color. — **Yellowish brown to brownish red** or nearly black.
Streak. — White.
Cleavage. — **Perfect basal.**
Thin cleavage lamellae are flexible, elastic, and tough.
Sectile.
Transparent to translucent.
Thin laminae often exhibit a six- or twelve-rayed star by transmitted light.

B. B. — Whitens and fuses on thin edges.

Occurs in large or small, **tapering, prismatic, pseudo-hexagonal, monoclinic crystals with a six-sided or rhombic cross-section**; rarely tabular.

Compare with Biotite (p. 204) and Jefferisite (p. 212).

Is used as an insulating material in electrical apparatus.

MUSCOVITE GROUP.

Members. — Muscovite, Lepidolite, Biotite, Phlogopite.

Composition. — Hydrous silicates of Aluminum and other bases.

Crystallization. — Monoclinic, pseudo-hexagonal.

Additional. — All are comparatively soft with a very perfect basal cleavage, and the cleavage lamellae are flexible and elastic.

BRITTLE MICA GROUP.

464. MARGARITE. $H_2CaAl_4Si_2O_{12}$. **Hardness 3.5-4.5.**

Lustre. — Vitreous to **pearly on cleavage face.**
Color. — **Pink**, gray, yellow or white.
Streak. — White.
Cleavage. — **Perfect basal.**
Cleavage lamellae are brittle.
Translucent to nearly opaque.

B. B. — Whitens and fuses on thin edges.

Occurs usually in **intersecting or aggregated laminae;** sometimes scaly massive, and very rarely in tabular, pseudo-hexagonal, monoclinic crystals.

Often associated with Corundum (p. 81) **and Diaspore** (p. 99).

Compare with Diaspore (p. 99), Muscovite (p. 202) and Lepidolite (p. 203).

466. CHLORITOID. $H_2(Fe,Mg)\,Al_2SiO_7$. **Hardness 6.5.**

Lustre. — High sub-metallic or slightly pearly on cleavage face.

Color. — **Dark greenish black**, grayish black or greenish gray.

Streak. — White, grayish or greenish.

Cleavage. — **Good basal.**

Cleavage plates are brittle.

Opaque to translucent in thin plates.

B. B. — Becomes darker and magnetic but is practically infusible.

Occurs usually in **cleavable, coarsely foliated masses**; also as disseminated plates or scales and, rarely, as tabular, pseudo-hexagonal monoclinic or triclinic crystals.

The cleavage, hardness, and brittleness will suffice to distinguish this from all similar minerals.

BRITTLE MICA GROUP.

Members. — Margarite, Chloritoid.

Composition. — Hydrous silicates of Aluminum and other bases.

Crytallization. — Monoclinic or triclinic, pseudo-hexagonal.

Additional. — Both have a prominent basal cleavage, yielding brittle plates, and both are relatively hard.

CHLORITE GROUP.

468. et seq. **CHLORITE.** Hydrous silicates of Al, Fe, and Mg. Hardness $\pm$ 2.

Lustre. — **Dull when massive**; slightly pearly on cleavage face.

Color. — **Dark green** to grass green.

Streak. — White or greenish.

Cleavage. — Perfect basal, often apparently absent due to the fineness of the scales or to alteration.

Cleavage lamellae are transparent and flexible but not elastic. Folia are very tough.

Sectile.

Opaque to transparent.

Massive material feels slightly soapy.

B. B. — Usually whitens and fuses with difficulty on edges to a nearly black glass; sometimes exfoliates.

Occurs **coarse to fine scaly, granular, and earthy**; in plates or disseminated scales; in monoclinic crystals which are usually pseudo-hexagonal and are sometimes vermicular; spheroidal or in fan-shaped or crested groupings; pseudomorphic, or distributed as a pigment through other minerals or rocks.

Varieties.

It is convenient to use the name Chlorite so as to embrace a number of very similar mineral species and to regard the latter as not always easily recognizable varieties, the two most important being:

468. CLINOCHLORE.

Apt to occur in large, light green, more or less transparent folia but is also found like Prochlorite, below.

469. PROCHLORITE.

Usually scaly granular and rather dull lustered masses.

Compare Clinochlore with Muscovite (p. 202), and Prochlorite with Serpentine (p. 214).

See Fig. 76.

[illegible]. [illegible]. A hydrous silicate of Al, Fe, and Mg. Hardness [illegible].

Luster. — Pearly to slightly greasy on cleavage face.

Color. — Yellowish brown.

Streak. — White.

Cleavage. — Perfect basal.

Cleavage lamellae are flexible but are neither elastic nor very tough.

Sectile.

Translucent to transparent.

B. B. — Exfoliates very remarkably and finally becomes white, opaque, and fuses to a gray mass.

Occurs usually in broad plates.

Compare with Biotite (p. 304) and Phlogopite (p. 305).

CHLORITE GROUP.

Members. — Chlorite, Jefferisite.

Composition. — Hydrous silicates of Aluminum, Iron and Magnesium, principally.

Crystallization. — Probably monoclinic; sometimes pseudo-hexagonal.

Additional. — Both are very soft and have a perfect basal cleavage, the cleavage lamellae being flexible but non-elastic.

FIG. 76. — Clinochlore, New York.

SERPENTINE-TALC DIVISION.

481. SERPENTINE. $H_2\left\{\begin{matrix}Mg\\Fe\end{matrix}\right\}_3 Si_2O_8+H_2O$. **Hardness** $\pm$**4.**

Lustre. — **Wax-like,** greasy or earthy, usually **feeble;** also **silky.**

Color. — **Light to dark green,** yellow, brownish red, nearly white, and variegated.

Streak. — White.

Conchoidal fracture when massive.

Tough.

Translucent to opaque.

Feels smooth and sometimes slightly greasy.

B. B. — Fuses only in thin fibres and then with difficulty.

Occurs usually **compact massive or coarse to fine fibrous, like Asbestus** (p. 152), **these two habits being often banded;** more rarely foliated or as pseudomorphs.

The compact material is microscopically granular or fibrous and felted, and the fibres of the fibrous variety are often easily separable and are usually flexible.

Varieties.

PRECIOUS or NOBLE SERPENTINE.

Massive, green material which is translucent even in thick pieces.

CHRYSOTILE.

The fibrous habit.

VERD ANTIQUE or OPHICALCITE.

A mixture of compact Serpentine and Calcite (p. 107); either granular or irregularly aggregated.

Compare the compact material with Cryptocrystalline Quartz (p. 68), Datolite (p. 179), Garnierite (p. 216) and Chrysocolla (p. 223).

Compare Chrysotile with Asbestus (p. 152) and Crocidolite (p. 154).

Serpentine takes a high polish and is much used as an ornamental stone, particularly the Verd Antique.

Chrysotile makes a very fine quality of commercial asbestus.

483. GARNIERITE. $H_2\left\{\begin{matrix}Ni\\Mg\end{matrix}\right\}SiO_4 + H_2O$. Hardness 2–4.

Lustre. — Varnish-like to dull.
Color. — Apple-green.
Streak. — Greenish white.
Brittle. Conchoidal to uneven fracture.
Opaque to translucent.
Only rarely adheres to the tongue.

B. B. — Decrepitates but does not fuse.

Occurs in earthy or loosely compact amorphous masses or crusts which often show a stalactitic or hemispherical surface and have a nodular structure.

Compare with Serpentine (p. 214) and Chrysocolla (p. 223).

The chief source of Nickel but it is said that the supply is greater than the demand.

484. TALC. $H_2Mg_3Si_4O_{12}$. **Hardness 1-1½.**

Lustre. — **Wax-like to pearly on cleavage face.**

Color. — **White, light green,** greenish gray, dark green, brown, red, silvery white.

Streak. — White or greenish.

Cleavage. — **Perfect basal.**

Thin plates are flexible but not elastic.

Sectile.

Transparent to translucent.

Feels greasy or soapy.

B. B. — Whitens and splits but is practically infusible.

Occurs usually **foliated massive;** also **coarse to fine granular** or compact; sometimes fibrous (pseudomorphous). Crystals (indistinctly orthorhombic or monoclinic) are almost unknown.

Varieties.

STEATITE or **SOAPSTONE.**

Coarse to fine granular masses which may be as hard as 2.5 due to admixture of impurities.

FRENCH CHALK.

Milk-white, granular or cryptocrystalline material which is soft enough to mark on cloth.

Compare the foliated material with Brucite (p. 105); Muscovite (p. 202) and Gypsum (p. 255).

Compare Soapstone with Chlorite (p. 210), Serpentine (p. 214), Kaolinite (p. 220) and Pyrophyllite (p. 221).

Can be sawn into slabs and used to line furnaces, hearths, etc., or carved into images and trinkets. Is used as chalk for marking on black-boards or cloth and to remove grease-spots from the latter. Also employed to adulterate sugar, flour, and paint and in the manufacture of porcelain, polishing powder (for Verd Antique, Alabaster, and glass), lubricants, gas-jets, tinted plasters, paper, soap, leather dressing, "Talcum Powder," slate-pencils, etc.

485. SEPIOLITE. $H_4 Mg_2 Si_3 O_{10}$. **Hardness 2-2.5.**

Lustre. — **Dull.**
Color. — **White,** grayish, yellowish or reddish; rarely bluish green.
Streak. — White.
Opaque.
Feels very smooth.
S. G. — **1-2.**

B. B. — Practically infusible but may split, blacken and give a burnt odor, then turn white.

Occurs in **tough, earthy masses** which are light enough to float on water when dry; also, rarely, fibrous.

Compare with Mountain Cork (p. 152) and Kaolinite (p. 220).

Used in making fine tobacco pipes and in some places as a building stone and as a substitute for soap.

KAOLIN DIVISION.

492. KAOLINITE. $H_4Al_2Si_2O_9$. Hardness 2-2.5.

Lustre. — **Dull** to pearly.
Color. — **White, gray,** yellowish, brownish, bluish, reddish.
Streak. — Same as the color.
Conchoidal to uneven fracture when massive.
Opaque to translucent.
When moistened, has a strong, earthy odor.
Often smooth or greasy to the touch.
Commonly plastic.

B. B. — Infusible.

Occurs usually in **compact, clay-like, or loose, mealy masses** which are often made up of microscopic pseudo-hexagonal monoclinic crystals or scales.
Is the principal constituent of clays.

The odor is distinctive.

It is the chief constituent of china, porcelain, stoneware, fire-bricks, fancy tiles, etc.

497. PYROPHYLLITE. $HAlSi_2O_6$. **Hardness 1-2.**

Lustre. — Folia are pearly; massive kinds are dull.
Color. — **White, brown,** green, yellowish, gray.
Streak. — White.
Cleavage. — **Perfect basal.**
Laminae are flexible but not elastic.
Translucent to opaque.
Feels greasy or soapy.

B. B. — Whitens and fuses on the edges with difficulty. The radiated variety exfoliates into fan-like forms.

Occurs usually in **radiated lamellar or bladed aggregates** or somewhat fibrous; also granular to compact massive, the latter being sometimes slaty.

Compare with Talc (p. 217).
The massive variety can only be distinguished from Soapstone (p. 217) by the B. B. test for Mg and Al.

The slaty variety is largely used for the manufacture of slate pencils.

See Fig. 78.

CONCLUDING DIVISION.

502. THAUMASITE. $\left\{\begin{matrix} CaSiO_3 \\ CaCO_3 \\ CaSO_4 \end{matrix}\right\} + 15\ H_2O$. Hardness 3.5.

Lustre. — **Dull.**
Color. — **White.**
Streak. — White.
Brittle. Sub-conchoidal fracture.
Translucent.

B. B. — Swells up and colors the flame red but is infusible.
Effervesces vigorously in cold HCl.

Occurs in **compact granular or slightly fibrous masses which are often crumbling on the surface and firm in the interior.**

Usually associated with Pectolite (p. 148), **Prehnite** (p. 184) **or some of the Zeolites.**

The appearance and associates are distinctive.

504. CHRYSOCOLLA. $CuSiO_3 + 2H_2O$. **Hardness 2-4.**

Lustre. — Vitreous to **dull.**

Color. — **Blue to bluish green** or green; sometimes black when impure. **Often spotted with brown** or entirely brown when mixed with Limonite (p. 102).

Streak. — White when pure.

Brittle. **Conchoidal fracture.**

Translucent to opaque.

Usually adheres strongly to a dry tongue.

B. B. — Decrepitates, turns black, then brown, and gives Cu flame but is infusible.

Occurs in **smooth, amorphous masses,** opal-like incrustations or seams, earthy, and sometimes botryoidal.

Compare with Opal (p. 75), Malachite (p. 125); Garnierite (p. 216) and Turquois (p. 241).

A rather unimportant ore of Copper and is sometimes used as a poor imitation of Turquois (p. 241).

TITANO-SILICATES.

510. TITANITE. $CaTiSiO_5$. Hardness 5–5.5.

Lustre. — Adamantine to **resinous.**
Color. — **Brown** to black, yellow; rarely, green or rose-red.
Streak. — Usually white.
Often has a **perfect parting** due to twinning parallel to one or both faces of a very steep (–) pyramid.
Brittle.
Transparent to opaque.

minus sign.

B. B. — Usually becomes yellow and then fuses easily with intumescence to a yellow to black glass.

Occurs usually in tabular or **wedge-shaped monoclinic crystals or platy massive**, rarely lamellar.

Varieties.

LEUCOXENE.

A dull, white, opaque, usually **granular** alteration product.

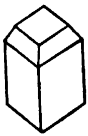

Fig. 77.

TITANITE.

The name is sometimes confined to the brown to black material.

SPHENE.

A synonymous name for the species but sometimes confined to the light colored varieties.

The appearance and manner of occurrence are usually distinctive.

The transparent, colored varieties are sometimes used as gems.

514. ASTROPHYLLITE. $\left\{\begin{matrix} H \\ Na \\ K \end{matrix}\right\}_4 \left\{\begin{matrix} Fe \\ Mn \end{matrix}\right\}_4 Ti(SiO_4)_4$

Hardness 3.

Lustre. — **Bronzy** or pearly.
Color. — **Bronze-yellow** to gold-yellow.
Streak. — White.
Cleavage. — **Perfect brachy-pinacoidal.**
Cleavage laminae are brittle.
Translucent to opaque.

B. B. — Swells and fuses easily to a black magnetic enamel.

Occurs usually in **very slender, bladed, micaceous crystals or strips**; rarely in distinct orthorhombic crystals with strongly striated faces.

The blades are usually very confusedly arranged, but are sometimes in stellate groups, and are **usually imbedded in Quartz** (p. 68).

The appearance and manner of occurrence are distinctive.

NIOBATES AND TANTALATES.

525. COLUMBITE. $\left\{\begin{matrix}Fe\\Mn\end{matrix}\right\}Nb_2O_6$. Hardness 6.

Lustre. — **Bright sub-metallic** to almost resinous.
Color. — Black, **often iridescent,** rarely brown.
Streak. — **Dark reddish brown** to black.
Cleavage. — **Good macro-pinacoidal and fair brachy-pinacoidal.**
Brittle.
Opaque to translucent.
S. G. — ± **6.**

B. B. — Unaltered. If fused with KOH and boiled with Sn, a deep blue solution results.

Occurs usually in **short, prismatic orthorhombic crystals or groups of parallel crystals;** also massive.
Usually found in veins in granite.

Variety.

TANTALITE.

Like Columbite but the Nb is more or less completely replaced by Ta. The S. G. is higher for Tantalite than for Columbite.

Compare with Wolframite (p. 259).

529. SAMARSKITE. $\left\{\begin{matrix} Fe \\ Ca \\ UO_2 \end{matrix}\right\}_3 \left\{\begin{matrix} Ce \\ Y \\ Di \\ La \\ Er \end{matrix}\right\}_2 \left\{\begin{matrix} Nb \\ Ta \end{matrix}\right\}_6 O_2.$ Hardness 5–6.

Lustre. — **High vitreous.**
Color. — **Coal-black.**
Streak. — Dark reddish brown.
No cleavage. Conchoidal fracture.
Brittle.
Nearly opaque.
S. G. — **5.6-5.8.**

B. B. — Fuses with difficulty on the edges to a black glass. Often yields reactions for Fe.

Occurs usually **massive** or as flattened, disseminated grains; rarely in rough orthorhombic crystals.

The appearance and S. G. are distinctive.

FIG. 78. — Pyrophyllite,
Guilford County, North Carolina.

PHOSPHATES, ARSENATES, VANADATES, ETC.

537. MONAZITE. $\left\{\begin{matrix} Ce \\ La \\ Di \\ Y \\ Er \end{matrix}\right\} PO_4 + \left\{\begin{matrix} SiO_2 \\ ThO_2 \end{matrix}\right\}$. Hardness 5–5.5.

Lustre. — **Resinous.**
Color. — **Yellow, brown,** brownish **red.**
Streak. — White.
Cleavage. — **Good to perfect basal.**
Brittle.
Nearly transparent to opaque.
S. G. — 4.9–5.3.

B. B. — Infusible but turns gray.

Occurs massive; as disseminated grains; **as rolled grains with Garnet** (p. 163), **Magnetite** (p. 89) **and other heavy sands**; rarely in small to large and coarse monoclinic crystals.

The cleavage will distinguish this from all similar minerals. This cleavage can often be seen by cracking some of the grains on an anvil and examining the fragments with a hand-lens.

This is the chief source of the rare earths of which it is composed. Some of these are in great demand for use in manufacturing gas-mantles.

APATITE GROUP.

549. APATITE. $\left\{\begin{matrix}CaF\\CaCl\end{matrix}\right\}$ $Ca_4P_2O_{12}$. **Hardness 4.5-5.**

Lustre. — Vitreous to resinous or dull.
Color. — **Green**, yellow, brown, gray, red, violet, white.
Streak. — White.
Cleavage. — **Practically none.**
Brittle. Conchoidal to uneven fracture.
Transparent to opaque.

B. B. — Fuses with difficulty on the edges and gives the blue-green P flame upon the addition of H_2SO_4.

Occurs in pyramidal hemihedral **hexagonal crystals, usually showing the basal-pinacoid and a flat pyramid and a prism of the same order,** third order forms being very rare; also granular to compact **massive** and in dull gray or white masses, often globular or reniform, with a more or less evident fibrous or columnar structure.

Varieties.

ASPARAGUS STONE.

Pale yellowish green crystals.

PHOSPHORITE.

Concretionary or stalactitic masses with a fibrous or scaly structure and a hardness of 4.5.

PHOSPHATE ROCK.

Massive gray, white, brown or black material with a hardness of 2–5.

OSTEOLITE.

Compact, earthy, impure, altered, white or gray material with a hardness of 1–2.

The hardness will distinguish the crystalline material from all similar minerals.

B. B. tests will often have to be used to distinguish the massive varieties from similar species, particularly the carbonates.

After treatment with H_2SO_4, to form soluble phosphates, Apatite forms the principal ingredient of most fertilizers.

Phosphorus is also obtained from this mineral.

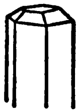

FIG. 79.

550. PYROMORPHITE. (PbCl) $Pb_4P_3O_{12}$. **Hardness 3.5-4.**

Lustre. — **Resinous.**

Color. — **Green**, gray, brown, orange, yellow, white.

Streak. — White or yellowish.

Brittle. Uneven to sub-conchoidal fracture.

Translucent to opaque.

B. B. — On charcoal, fuses very easily, yielding sublimates of lead oxide and chloride, and the globule on cooling has a polyhedral, crystalline form.
In forceps, gives blue-green flame.

Occurs usually in **tapering groups of prismatic pyramidal hemihedral hexagonal crystals in parallel positions**; also in single crystals which are usually horizontally striated and are often barrel-shaped or show a hollow basal-pinacoid and prism with perhaps a pyramid of the same order, third order forms being very rare; sometimes globular, botryoidal, fibrous or granular.

Compare with Mimetite (p. 233).

An ore of Lead.

551. MIMETITE. (PbCl) $Pb_4As_3O_{12}$. **Hardness 3.5.**

Lustre. — **Resinous** to adamantine.
Color. — **Pale yellow to brown;** sometimes white or colorless.
Streak. — White.
Brittle. Uneven fracture.
Translucent.

B. B. — On charcoal, fuses very easily, yielding sublimates of lead chloride and oxide, and arsenic oxide, finally reducing to metallic Pb.

Occurs in **tapering groups of prismatic pyramidal hemihedral hexagonal crystals in parallel position,** like Pyromorphite (p. 232) in habit; also in **globular groups** and in **mammillary crusts.**

Compare with Pyromorphite (p. 232).

552. VANADINITE. (PbCl) $Pb_4V_3O_{12}$. Hardness 3.

Lustre. — **Resinous** on fracture.

Color. — **Deep red,** reddish brown, yellowish brown or yellow.

Streak. — White to yellowish.

Brittle. Uneven or flat conchoidal fracture.

Translucent to opaque.

B. B. — Fuses easily on charcoal to a black mass, yielding sublimates of lead chloride and oxide.

Occurs usually in **sharply crystallized, prismatic pyramidal hemihedral hexagonal crystals, often showing third order forms and a hollow basal-pinacoid;** also in parallel groupings, rounded forms, and crusts like Pyromorphite (p. 232) and Mimetite (p. 233).

The crystallization and color are usually distinctive.

This is the source of the Vanadium salts used as a pigment and in several arts and trades.

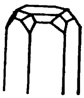

Fig. 80.

APATITE GROUP.

Members. — Apatite, Pyromorphite, Mimetite, Vanadinite.

Composition. — Phosphates etc. of Calcium or Lead with Chlorine and sometimes Fluorine.

Crystallization. — Pyramidal hemihedral hexagonal.

Additional. — Though of differing hardness, they can all be scratched with a knife and none shows cleavage.

MISCELLANEOUS PHOSPHATES, ARSENATES, ETC.

561. OLIVENITE. $Cu_2(OH)AsO_4$. Hardness 3.

Lustre. — Vitreous or adamantine to silky.
Color. — Olive-green to yellow or brown.
Streak. — Olive-green to brown.
Practically no cleavage. Conchoidal to uneven fracture.
Brittle.
Nearly transparent to opaque.

B. B. — On charcoal, fuses easily and with a sudden and sparkling combustion, yielding the sublimate of arsenic oxide, a metallic globule of arsenide of copper, and a bluish green flame.

Occurs in needle-like orthorhombic crystals forming velvety crusts; more rarely, in indistinctly fibrous, granular or earthy, nodular masses.

Usually associated with Limonite (p. 102), Malachite (p. 125), Quartz (p. 68), Barite (p. 247), Calcite (p. 107), etc.

The color and manner of occurring are usually distinctive.

An unimportant ore of Copper.

574. LAZULITE. $2AlPO_4 . (Fe,Mg)(OH)_2$. Hardness 5-6.

Lustre. — Vitreous to dull.
Color. — **Azure-blue.**
Streak. — White.
Cleavage. — None. Uneven fracture.
Brittle.
Opaque.

B. B. — In the forceps is infusible but whitens, cracks, swells, and falls to pieces, coloring the flame bluish green, particularly when moistened with H_2SO_4.

Occurs in **acutely pyramidal monoclinic crystals which are often twinned** parallel to the ortho-pinacoid, the twinning plane appearing to be perpendicular to the C axis.

Compare with Turquois (p. 241).

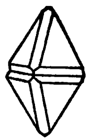

Fig. 81. — Twin.

597. VIVIANITE. $Fe_3P_2O_8 + 8H_2O$. **Hardness 1.5-2.**

Lustre. — Vitreous to dull.

Color. — **Indigo-blue** or green, deepening on exposure to the light. Colorless before exposure.

Streak. — **Indigo-blue.** The colorless or light colored material gives a colorless or bluish streak which soon changes to indigo blue.

Cleavage. — **Perfect pinacoidal.**

Sectile. Flexible in thin laminae; otherwise brittle.

Transparent to opaque.

Dichroic. — Green and blue.

B. B. — Fuses very easily to a black, magnetic globule, coloring the flame bluish green, particularly after moistening with H_2SO_4.

Occurs usually in **radiating, bladed aggregates of monoclinic crystals**; also fibrous, incrusting or in earthy masses replacing organic material.

Compare with Azurite (p. 126).

628. CONICHALCITE. $\left\{\begin{matrix}Cu\\Ca\end{matrix}\right\}_3 As_2O_8 . \left\{\begin{matrix}Cu\\Ca\end{matrix}\right\}(OH)_2 + \frac{1}{2}H_2O$.

Hardness 4.5.

Lustre. — Dull to waxy.
Color. — **Bright green.**
Streak. — Like color.
Splintery fracture.
Nearly opaque.

B. B. — On charcoal, fuses with a sudden and sparkling combustion to a red slag-like mass. In the forceps, fuses, yielding an emerald-green flame.

Occurs **in small botryoidal or globular masses which show neither a fibrous or radiating structure,** being amorphous; rarely massive.

Compare with Malachite (p. 125).

639. WAVELLITE. $4AlPO_4 . 2Al(OH)_3 + 9H_2O$.
Hardness 3.5–4.

Lustre. — **Pearly** or brilliant vitreous.
Color. — **Green,** white, yellow, colorless, blue, gray, brown, black.
Streak. — White.
Cleavage. — Good brachy-pinacoidal.
Brittle.
Translucent.

B. B. — Whitens, swells, and splits into fine needle-like particles, but does not fuse.

Occurs in **hemispherical or globular aggregates** of indistinct orthorhombic crystals with a crystalline surface and **radiating structure.**

Compare with Prehnite (p. 184) and Thomsonite (p. 198).

642. TURQUOIS. $AlPO_4 . Al(OH)_3 + H_2O + nCu$.

Hardness 6.

Lustre. — **Dull** to feebly waxy.
Color. — **Deep blue** to apple green.
Streak. — White or greenish.
Cleavage. — **None.** Conchoidal fracture.
Rather brittle.
Nearly or quite opaque.

B. B. — In the forceps, infusible but turns brown and becomes glassy. Yields P flame with H_2SO_4 and Cu flame with HCl.

Occurs usually in **amorphous** or **cryptocrystalline nodules** or **veins**; also stalactitic, incrusting, as disseminated grains, and in rolled masses.

Compare with Malachite (p. 125), Amazon Stone (p. 133) and Chrysocolla (p. 223).

It makes a popular and valuable gem when of good color and hardness, but is very easily imitated.

BORATES.

698. BORACITE. $Mg_7Cl_2B_{16}O_{30}$. Hardness 4.5 or 7. (See below.)

Lustre. — Vitreous.

Color. — Colorless or white; sometimes grayish, yellowish or greenish.

Streak. — White.

Brittle. Conchoidal to uneven fracture.

Transparent to opaque.

The massive variety often contains soluble salts which give it an astringent taste.

B. B. — Fuses easily with intumescence to a white, pearly glass, giving a yellowish green flame.

Occurs in **inclined hemihedral isometric crystals** which are usually isolated and imbedded; also in snow-white earthy masses.

Usually associated with Anhydrite (p. 251), Gypsum (p. 255) or Salt (p. 61).

The hardness of crystals is 7 and of the massive material 4.5 or much less.

Variety.

STASSFURTITE.

The massive material with an earthy or, rarely, a sub-columnar structure.

Compare the crystals with Zunyite (p. 162).

Compare the massive material with Chalk (p. 109) and Borax (p. 244).

704. COLEMANITE. $Ca_2B_6O_{11} + 5H_2O$. **Hardness 4-4.5.**

Lustre. — Brilliant vitreous to dull.
Color. — White, colorless, yellowish, grayish.
Streak. — White.
Cleavage. — **Perfect brachy-pinacoidal.**
Brittle.
Transparent to opaque.

B. B. — Decrepitates, exfoliates, and fuses imperfectly, coloring the flame yellowish green.

Occurs usually as **geodes of transparent, colorless, complex monoclinic crystals in the massive material**; also cleavable and chalky or porcelain-like massive.

Varieties.

PRICEITE.

Loosely adherent, chalky masses.

PANDERMITE.

Compact, porcelain-like masses.

Compare the crystallized material with Topaz (p. 174), Heulandite (p. 192), Stilbite (p. 193) and Gypsum (p. 255).
Compare the massive material with Chalk (p. 109) and Cryptocrystalline Quartz (p. 71).

707. BORAX. $Na_2B_4O_7 + 10H_2O$. **Hardness 2-2.5.**

Lustre. — Vitreous or resinous to dull.

Color. — White; sometimes grayish, bluish, greenish.

Streak. — White.

Rather brittle. Conchoidal fracture.

Transparent when first formed but becomes earthy and opaque on exposure.

Has a disagreeable, alkaline taste, but this is not strong.

B. B. — Swells greatly, finally fusing easily to a transparent glass.

Occurs as a glistening efflorescence on certain soils or as a constituent of the same, and as well formed monoclinic crystals — sometimes weighing a pound each — in the mud of Borax lakes.

The taste and appearance are usually distinctive.

Is used in great quantities in many arts and trades.

URANATES.

711. **URANINITE.** See below. Hardness 5.5.

Lustre. — **Pitch-like**, sub-metallic, dull.
Color. — Nearly black; sometimes grayish, greenish or brownish.
Streak. — **Olive-green**, gray, dark brown.
Brittle. Conchoidal to uneven fracture.
Opaque.
S. G. — **6.4-9.7.**

B. B. — **Infusible**, or slightly rounded with great difficulty on the edges.
Gives the bead tests for Uranium.

Occurs botryoidal or granular massive and, rarely, in small isometric crystals.

The composition is very variable and complex but it may be said to be a uranate of uranyl (UO_2) and Lead, usually with Thorium or Zirconium and with the metals of the Lanthanum and Yttrium groups often present; also Nitrogen, Calcium, water and Radium are always present in small quantities; also Iron as an impurity.

Compare with Samarskite (p. 227).

This mineral is the chief source of the Uranium compounds used to color glass and porcelain, and is also in demand for radio-active experiments.

ANHYDROUS SULPHATES, CHROMATES, ETC.

716. THENARDITE. Na_2SO_4. Hardness 2–3.

Lustre. — **Greasy vitreous.**
Color. — White, **grayish**, brownish.
Streak. — White.
Cleavage. — Practically none. Uneven fracture.
Rather brittle.
Translucent to transparent.
Tastes bitter and salty.

B. B. — On charcoal, fuses easily to a mass which will stain clean silver, giving a deep yellow flame.

Occurs usually in **tabular orthorhombic crystals with rough faces and pointed ends, either simple or as crossed twins**; sometimes pyramidal in habit, or massive; also as an efflorescence on alkali earth.

The taste and appearance are distinctive.

See Fig. 82.

BARITE GROUP.

719. BARITE. $BaSO_4$. **Hardness 2.5–3.5.**

Lustre. — Vitreous; sometimes pearly on the basal-pinacoid.
Color. — White, yellow, gray, blue, brown, red.
Streak. — White.
Cleavage. — **Perfect basal and fair prismatic,** the angle of the latter being 101° 38′.
Brittle.
Transparent to opaque.
S. G. — **4.3–4.6.**
Sometimes fetid when rubbed.

B. B. — Decrepitates and fuses fairly easily, yielding Ba flame.

Occurs in **well formed orthorhombic crystals** (see below), aggregates of indistinct tabular crystals united parallel to the flat faces, and **cleavable masses of straight or curved lamellae**; also granular, fibrous, earthy, in globular forms, and like banded stalactite.

Found very commonly as part of the gangue of metallic ores, especially those of lead.

Crystals.

Most of these fall under one of the following habits:

1. *Rhombic Tabular.* The basal-pinacoid and prism are the main forms, the flattening being parallel to the former.
2. *Rectangular Tabular.* The basal-pinacoid and macro- and brachy-domes are the main forms, the flattening being parallel to the first.
3. *Prismatic.* The elongation is usually parallel to the B axis with a macro-dome as the most prominent form.

Rarely the elongation is parallel to the C or A axes.
Broken crystals can always be oriented by means of the cleavage.

The S. G., hardness, cleavage, and non-effervescence in acids are distinctive.

Some varieties take a fine polish and look like, and are used in place of Marble (p. 108). Considerable amounts are used to give weight to paper and great quantities are consumed in the adulteration of white lead, the adulterated article being in some respects better than the pure lead.

See Figs. 83 and 84.

720. CELESTITE. $SrSO_4$. Hardness 3–3.5.

Lustre. — Vitreous; sometimes pearly on the basal-pinacoid.

Color. — **Light blue**, white, reddish.

Streak. — White.

Cleavage. — **Good basal and poor prismatic**, the angle of the latter being 104° 20′.

Brittle.

Transparent to nearly opaque.

S. G. — **3.95-3.97.**

B. B. — Usually decrepitates and fuses fairly easily to a white pearl, yielding Sr flame.

Occurs in **orthorhombic crystals with the habits of Barite** (p. 247); also cleavable massive, granular, fibrous and radiated; sometimes globular.

Often associated with Sulphur (p. 3); also in beds of Limestone (p. 109), Gypsum (p. 255) or Salt (p. 61).

Compare with Barite (p. 247).

Is a source of the strontium nitrate used as "red fire" in fireworks.

721. ANGLESITE. $PbSO_4$. Hardness 2.75–3.

Lustre. — **High adamantine** to vitreous when in crystals; **resinous** to dull when massive.

Color. — White to colorless; also gray, yellow, and light green or blue.

Streak. — White.

Cleavage. — **Very poor** basal and prismatic; **usually not apparent.**

Very brittle.

Transparent to opaque.

S. G. — **6.12-6.39.**

B. B. — On charcoal, decrepitates and fuses very easily to a globule which is milk-white on cooling. In R. F. is reduced with effervescence to metallic Lead.

Occurs in more or less distinct orthorhombic **crystals in cavities in Galenite** (p. 26), being formed by alteration of that mineral; commonly in **concentric layers around, or pseudomorphous after Galenite,** frequently showing its rectangular cleavage by bands of color along the same; sometimes stalactitic or in nodular forms.

Compare with Cerussite (p. 122), Barite (p. 247) and Celestite (p. 249).

An ore of Lead and frequently carries Silver.

722. ANHYDRITE. $CaSO_4$. Hardness 3–3.5.

Lustre. — Vitreous or pearly.

Color. — **Gray, blue,** white, brown, reddish.

Streak. — White.

Cleavage. — **Perfect to good, parallel to basal-, brachy-, and macro-pinacoids — pseudo-cubic.** Not apparent on most massive varieties.

Brittle.

Translucent to opaque.

B. B. — Fuses fairly easily to a white enamel, yielding Ca flame.

Occurs cleavable massive, yielding rectangular fragments and **coarse to fine granular — marble-like**; also fibrous, lamellar or columnar; rarely in orthorhombic crystals.

Variety.

VULPINITE.

Scaly, granular, siliceous material.

Compare with Halite (p. 61) and Calcite (p. 107).

Vulpinite is cut and polished as an ornamental stone. Anhydrite absorbs water and swells, so cannot be used for building purposes.

BARITE GROUP.

Members. — Barite, Celestite, Anglesite, Anhydrite.

Composition. — Sulphates.

Crystallization. — Orthorhombic.

Additional. — All are about 3 in hardness, and all have some degree of cleavage in three directions.

FIG. 82. — Thenardite, Borax Lake, California.

FIG. 83. — Barite, Aspen, Colorado.

FIG. 84. — Barite, Cumberland, England.

725. CROCOITE. $PbCrO_4$. Hardness 3–3.5.

Lustre. — Adamantine to vitreous.
Color. — **Bright carnelian-red.**
Streak. — **Orange-yellow.**
Cleavage. — Good prismatic at angle of 86° 19′, but cleavage faces are often rough and deeply striated.
Very brittle.
Translucent.
S. G. — 5.9–6.1.

B. B. — On charcoal, fuses very easily with a sudden and sparkling combustion, reducing to metallic lead, giving a sublimate of lead oxide and finally yielding a residue of chromium oxide.

Occurs usually in **deeply striated, columnar or prismatic aggregates**; rarely in distinct monoclinic crystals of varied habit but usually prismatic; sometimes granular.

Compare with Realgar (p. 18), Vanadinite (p. 234) and Wulfenite (p. 262).

See Fig. 85.

HYDROUS SULPHATES.

746. GYPSUM. $CaSO_4 + 2H_2O$. **Hardness 1.5-2.**

Lustre. — **Pearly, silky,** vitreous, dull.

Color. — **White,** gray, red, yellow, blue. Sometimes brown or black when impure.

Streak. — White.

Cleavage. — **Very perfect clino-pinacoidal,** fair ortho-pinacoidal, and fair parallel to the positive unit pyramid. **The last two cleavages usually appear as cracks at an angle of 114° in the polished laminae afforded by the perfect cleavage.**

Thin cleavage laminae are more or less flexible, depending upon the direction in which they are bent.

Transparent to opaque.

B. B. — Becomes white and opaque and fuses easily, yielding Ca flame.

Occurs in **well-formed monoclinic crystals** which are sometimes twinned in " swallow-tail " forms, and foliated, compact, **granular, fibrous, and cleavable massive.**

Varieties.

SELENITE.

Crystals and transparent, cleavable plates or strips.

SATIN SPAR.

White and delicately fibrous with a silky lustre.

ALABASTER.

White or delicately shaded, finely granular material.

ROCK-GYPSUM.

Impure, dull colored, scaly to compact material.

The hardness and cleavage should be sufficient to distinguish Gypsum from all similar minerals.

The pure varieties when calcined and ground form plaster of Paris and the impure material is used in many cements. Satin Spar is used in cheap jewelry and Alabaster is easily carved into beautiful statues, vases, etc. Gypsum is also sometimes powdered and used to improve soils.

See Fig. 86.

800. ALUNITE. $K_2O.3Al_2O_3.4SO_3.6H_2O$. Hardness 3.5–4.

Lustre. — **Dull** when massive; vitreous when crystalline.
Color. — White with a very **faint flesh tint,** sometimes grayish.
Streak. — White.
Cleavage. — Practically none. **Conchoidal fracture when massive,** uneven when crystalline.
Transparent to nearly opaque.

B. B. — Decrepitates, but is infusible.

Occurs usually **porous granular to compact crypto-crystalline**; the latter being often intermixed with siliceous material; also in nearly cubical rhombohedral crystals or druses of the same in the massive material; sometimes fibrous.

Cracks and cavities in the massive material are usually coated with Limonite (p. 102).

Compare with Chert (p. 72) and Magnesite (p. 112).

By calcination, soluble sulphates are formed. These, when evaporated, yield Roman alum which is highly valued by dyers, because, although colored red by iron oxide, it contains no chemically combined iron.

Alunite rock is sometimes used for millstones.

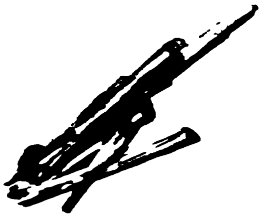

Fig. 85.—Crocoite, Dundas, Tasmania.

Fig. 86.—Gypsum, Mahoning County, Ohio.

TUNGSTATES AND MOLYBDATES.

312. WOLFRAMITE. $(Fe,Mn)WO_4$. Hardness 5–5.5.

Lustre. — Sub-metallic.
Color. — **Black** or dark gray.
Streak. — Dark brown to black.
Cleavage. — **Perfect brachy-pinacoidal.**
Brittle.
Opaque.
S. G. — **7.2–7.5.**

B. B. — **Fuses easily to a crystalline, magnetic globule.**

Occurs in **coarsely columnar or bladed aggregates with the cleavage prominent;** also frequently in pseudo-orthorhombic, monoclinic crystals which are usually bladed and vertically striated; sometimes coarse to fine **granular.**

Compare the cleavable material with Huebnerite (p. 260). Compare the granular material with granular Magnetite (p. 89).

Wolframite is used in large quantities in the manufacture of "tungsten steel" and various tungsten salts.

813. HUEBNERITE. $MnWO_4$. Hardness 5–5.5.

Lustre. — Submetallic or **bronze-like to resinous.**

Color. — **Brown or reddish brown.** Sometimes black. **Thin fragments are often red by transmitted light.**

Streak. — Brown.

Cleavage. — **Perfect brachy-pinacoidal.**

Brittle.

Translucent to opaque.

S. G. — **7.2-7.5.**

B. B. — Fuses with difficulty to a dark globule.

Occurs in **radiating, bladed aggregates** with a rough parting along the broad faces, readily yielding plates in this direction, this parting being more prominent than the cleavage.

Often forms veins in Quartz (p. 68).

Compare with Astrophyllite (p. 225) and Wolframite (p. 259).

Used in large quantities in the manufacture of "tungsten steel" and various tungsten salts.

See Fig. 88.

SCHEELITE GROUP.

814. SCHEELITE. $CaWO_4$. Hardness 4.5–5.

Lustre. — Vitreous to **adamantine.**

Color. — Pale yellow, brown or gray; sometimes white, green, reddish or orange.

Streak. — White.

Practically no cleavage. Uneven fracture.

Brittle.

Translucent to transparent.

S. G. — **5.9-6.1.**

B. B. — Fuses with great difficulty on thin edges. With salt of phosphorous forms a glass which is colorless in the oxidizing, and blue in the reducing flame.

Occurs in **well formed pyramidal hemihedral tetragonal crystals** — either individuals or in drusy crusts — usually pyramidal in habit but sometimes tabular parallel to the basal-pinacoid; also granular massive.

Compare with Zircon (p. 173.)

Used in the manufacture of " tungsten steel" and various tungsten salts.

FIG. 87.

318. WULFENITE. $PbMoO_4$. Hardness 2.75–3.

Lustre. — **Resinous** to adamantine.

Color. — **Bright red to orange**; sometimes brown, grayish white or nearly colorless; rarely green.

Streak. — White.

Cleavage. — Good pyramidal.

Very fragile and brittle.

Nearly transparent to nearly opaque.

S. G. — **6.7-7.**

B. B. — On charcoal, fuses very easily, yielding lead oxide sublimate and finally a metallic globule.

Occurs usually in **decidedly tabular pyramidal hemihedral tetragonal crystals**, sometimes very thin and showing the basal-pinacoid and second order pyramid as common, and the third order pyramid as rare, forms. Less frequently the crystals show short, rounded prisms or are pyramidal in habit.

The mineral also occurs granular massive and sometimes the crystallization is so indistinct that the mass appears platy.

Always associated with other Lead ores.

Compare with Vanadinite (p. 234) and Crocoite (p. 254).

An unimportant ore of lead.

See Fig. 89.

SCHEELITE GROUP.

Members. — Scheelite, Wulfenite.

Composition. — Tungstates and molybdates.

Crystallization. — Pyramidal hemihedral tetragonal.

The group is otherwise not well characterized.

FIG. 88.—Huebnerite, Gladstone, Colorado.

FIG. 89.—Wulfenite, Arizona.

(?) **CARNOTITE.** See below. **Hardness about 1.**

Lustre. — **Dull** to slightly resinous.
Color. — **Canary-yellow.**
Streak. — Lemon-yellow.
Brittle. Uneven fracture.
Opaque.

B. B. — In forceps or on charcoal, fuses easily with intumescence to a dull-lustered black globule.

Occurs as a powder or in loosely cohering to compact earthy masses. Usually intimately mixed with Quartz sand.

Sometimes associated with an olive-green Vanadium mica.

Compare with Sulphur (p. 3) and Orpiment (p. 19).

This does not seem to be a homogeneous substance but appears to be made up of several unidentified minerals. In general, its composition may be said to be a vanadate of Uranium and Potassium, containing many other bases, including Radium.

HYDROCARBONS.

OZOCERITE. C_nH_{n+2}. **Hardness ± 1.**

Lustre. — **Waxy.**

Color. — **Brown**, yellow brown, yellow, green, and colorless to white when pure. The brown material is sometimes green by transmitted light.

Streak. — Light-brown to colorless.

Malleable.

Translucent to nearly opaque.

Feels greasy, and has a decided odor.

S. G. — .85–.90.

B. B. — **Fuses in a match flame.**

Occurs in structureless or foliated **masses which look like, and possess all the properties of Bees-wax except its stickiness.**

It is a natural Paraffin.

The appearance is distinctive.

Is used in manufacturing all the products for which Paraffin is in demand.

AMBER. $C_{10}H_{16}O$. **Hardness 2-2.5.**

Lustre. — **Resinous.**

Color. — **Yellow**, reddish, brownish.

Streak. — White.

Conchoidal fracture.

Brittle. Can be cut very easily.

Transparent to opaque.

S. G. — 1.05–1.096.

On being rubbed it becomes negatively electrified and will then pick up small pieces of paper.

B. B. — Melts very easily and gives off dense white fumes with a peculiar aromatic odor, irritating to the nostrils.

This is a fossil gum or resin which is usually found in loose deposits along coasts, sometimes being washed up on beaches by the waves during storms.

The appearance, softness, and lightness are characteristic.

Used principally in jewelry and for the mouth-pieces of fine pipes.

PETROLEUM. $C_nH_{2n+2}+$. **Thin to thick fluid.**

Lustre. — **Greasy,** watery.

Color. — **Greenish brown to black;** also colorless to dark yellow.

Translucent to transparent.

S. G. — 0.6–0.9.

Has a disagreeable, " oily " odor.

B. B. — Will burn readily when ignited with a match.

Occurs impregnating sedimentary rocks or collected in cavities in the same, usually beneath gently undulating anticlines. Sometimes seeps out on the surface from inclined strata, forming pools.

Varieties.

There are many varieties based on composition and fluidity, Petroleum varying from a thin, watery liquid, too inflammable to be used in lighting, to very thick, viscid fluids, and passing, by loss of the lighter naphthas through evaporation, by insensible gradations into the paraffins, bitumens or asphalts.

The uses of Petroleum are well known.

ASPHALTUM. Mixtures of different hydrocarbons. **Hardness ± 1.**

Lustre. — **Resinous, pitch-like,** dull.
Color. — **Black,** brownish black.
Streak. — Brown.
Conchoidal to uneven fracture.
Brittle. Can be cut very easily.
Opaque to transparent.
S. G. — 1–1.8.
Odor is bituminous.

B. B. — **Melts in a match flame,** burning with a bright flame.

Found impregnating, or filling cavities in rocks of all ages, but the most important deposits are in the form of "lakes" or beds on the surface. Such deposits as the last mentioned are probably always connected with rocks containing bituminous material or organic remains.

Varieties.

There are many varieties based upon the composition, ease of melting, and various physical features.

Compare with Coal (p. 269).

The uses of Asphaltum in street-paving, roofing, as a wood preservative, etc., are well known.

COAL. Oxygenated Hydrocarbons +. Hardness .5–3.

Lustre. — Sub-metallic to dull, also resinous.
Color. — Black to brown, sometimes iridescent.
Streak. — Black to brownish.
Fracture. — Conchoidal to uneven. Rectangular jointing and parting common.
Brittle to tough.
Opaque.

B. B. — **Burns** more or less freely **without melting.**

Occurs interstratified with sedimentary rocks and beds of iron ore, having been formed by the gradual changes produced in beds of organic materials (chiefly vegetable) through the agency of pressure and more or less heat.

Is usually massive but is sometimes laminated or delicately banded, the different bands differing in color.

Varieties.

The varieties of coal are based principally on the amount of volatile matter yielded by distillation and on the nature of these compounds. To a less extent the distinctions are based on physical characters.

It is seldom safe to decide the class to which a given specimen of coal belongs without basing the determination on something besides appearance or physical properties.

LIGNITE or **BROWN COAL.**

Non-coking, often impure coals containing a large amount of volatile matter. They are of recent origin and the name Lignite is often confined to those varieties which still plainly show the woody structure. Lignite is easily ignited.

The color ranges from **brown** to pitch black and they

are sometimes so compact and hard as to closely resemble Bituminous Coal or even Anthracite, but are usually **comparatively soft.** Lustre often **resinous.**

JET.

Hard, black Lignite **with a high lustre** which takes a fine polish and is used in jewelry.

BITUMINOUS COAL.

Coking or non-coking coals with a very large amount (20%–40%) of volatile matter.

The color is **black,** the texture firm and compact and the lustre usually **bright or pitchy.**

Usually **harder than Lignite and softer than Anthracite.**

Easily ignited and **burns with a sooty, yellow flame.**

CANNEL or PARROT COAL.

Very compact and even in texture with **little lustre** and a **broad conchoidal fracture.**

This is a variety of Bituminous Coal and may be either coking or non-coking.

ANTHRACITE.

Hard, compact coal with a **high, often submetallic lustre.** Usually contains less than 5% volatile matter.

Ignited with difficulty and burns with a blue flame.

MINERAL COKE.

Resembles artificial coke but is apt to contain bituminous material and be more compact. It is usually plainly formed by metamorphism of coals in contact with igneous intrusions.

MINERAL CHARCOAL.

A fibrous or powdery substance often occurring between layers of coal. It is soft and soils the fingers.

COMMERCIALLY IMPORTANT ORES.

In the following table, the figures after each name of an ore indicate the percentage of the element specified which the pure mineral contains. When this is variable or is merely mechanically included, an interrogation mark takes the place of the above-mentioned figure.

Important ores are in **heavy face type,** less common species are in lighter type, and minerals which are only occasionally mined and treated for the element specified are in *italics.*

Each group is arranged in the order of decreasing importance.

ALUMINUM

Bauxite (73.9), Cryolite (12.8).

ANTIMONY.

Stibnite (71.8).

ARSENIC.

Arsenopyrite (46), **Smaltite** (71.8), **Cobaltite** (45.2), Niccolite (?), Enargite (19.1).

CHROMIUM.

Chromite (46.2).

COBALT.

Smaltite (?), Cobaltite (35.5), *Arsenopyrite (?)*.

COPPER.

Native Copper (95), **Chalcopyrite** (34.5), **Bornite** (55.5), **Cuprite** (88.8), Malachite (57.5), Chalcocite (79.8), Enargite (48.3), Tetrahedrite (?), Azurite (55.4), *Covellite (66.4)*, *Chrysocolla (45.2)*, *Atacamite (62.4)*.

GOLD.

Native Gold (99.8), **Pyrite** (?), **Sylvanite** (24.5), **Calaverite** (39.5), **Chalcopyrite** (?), Hessite (?), Petzite (25.5), Galenite (?), *Arsenopyrite (?)*, *Stibnite (?)*.

IRON.

Hematite (70), **Limonite** (59.8), **Magnetite** (72.4), Siderite (48.4), Goethite (62.9), *Pyrite (46.7)*.

LEAD.

Galenite (86.6), **Cerussite** (77.7), **Anglesite** (73.6), **Pyromorphite** (76.4), Mimetite (69.7), Vanadinite (73.2), Wulfenite (56.5), *Tetrahedrite (?)*.

MAGNESIUM.

Magnesite (28.6).

MANGANESE.

Pyrolusite (63.2), **Psilomelane** (?), Manganite (62.4).

MERCURY.

Cinnabar (86.2), *Native Mercury (99)*.

MOLYBDENUM.

Molybdenite (60.)

NICKEL.

Garnierite (?), **Pyrrhotite** (?), Millerite (64.4), Niccolite (43.9), *Chalcopyrite (?)*, *Arsenopyrite (?)*.

PLATINUM.

Native Platinum (86.5).

SILVER.

Galenite (?), **Cerargyrite** (75.3), **Pyrargyrite** (59.9), **Proustite** (65.4), **Argentite** (87.1), Tetrahedrite (?) Native Silver (95), Native Gold (?), Native Copper (?), Hessite (63), Petzite (43), Stephanite (68.5), *Pyrite (?), Chalcopyrite (?), Jamesonite (?), Stibnite (?), Cerussite (?), Polybasite (75.6).*

STRONTIUM.

Strontianite (56.8), Celestite (45.7).

SULPHUR

Pyrite (53.3), **Native Sulphur** (100), Pyrrhotite (?).

TIN.

Cassiterite (78.6).

TUNGSTEN.

Wolframite (60.7), Huebnerite (60.7), *Scheelite (63.9).*

ZINC.

Sphalerite (67), **Smithsonite** (52), **Calamine** (54.1), Zincite (80.8), *Franklinite (?), Willemite (58.4).*

Note: In the foregoing table, Marcasite is included under Pyrite, and Tennantite under Tetrahedrite.

RETAIL PRICES OF GOOD TO VERY FINE CUT GEMS.

Note: The value of gems depends upon four factors, *i.e.*, (1) the color, (2) freedom from flaws and inclusions, (3) the hardness, and (4) the coefficient of refraction.

Unless the color is unusually good and the material is uncommonly free from flaws, it will seldom pay to try to market uncut gem materials if listed at less than $2.00 per carat.

Good gems are occasionally quoted at lower figures than are here given and very large gems of the cheaper varieties often cost much less per carat than do smaller stones, but these figures are probably fair average values. Large gems of the more expensive varieties usually cost much more per carat than do the small ones.

The price charged by Lapidaries for cutting a single stone will vary from about $1.00 to $3.50 per carat according to the hardness of the mineral and the difficulties due to cleavage, etc., which are apt to be encountered. The cutting of Diamonds costs much more than this. When a great many stones of the minerals about 7 in hardness are cut at one time, a figure of as low as $0.20 apiece can sometimes be obtained if the stones are not over a carat in size.

A carat is a weight of about 3.2 Troy grains or 1/2187 of a pound Avoirdupois.

Uncut gem material is sold by the pound, or by the specimen if very valuable.

Most of the gems on this list are described on the preceding pages.

	Price per carat.
Alexandrite	$20.00 to $150.00
Amazon Stone	.50
Amethyst (Quartz)	.50 to 5.00
Amethyst, oriental	5.00 to 30.00
Aquamarine	4.00 to 20.00
Azurite	.75 to 2.00
Beryl (Aquamarine). (See Aquamarine.)	
Beryl, pink	5.00 to 10.00

	Price per carat.
Beryl (Emerald). (See Emerald.)	
Bloodstone. (See Heliotrope.)	
Chrysoberyl	$10.00 to $15.00
Chrysoberyl, var. Cat's Eye	5.00 to 20.00
Chrysocolla, siliceous	1.00 to 2.50
Chrysoprase	.50 to 2.00
Citrine	1.00 to 5.00
Cyanite	
Cymophane	20.00
Diamond, white	160.00 to 275.00
Diamond, brown	150.00 to 500.00
Diamond, canary yellow	500.00
Diamond, blue	250.00 to 500.00
Diopside	3.00 to 5.00
Emerald (Beryl)	25.00 to 200.00
Emerald, oriental	500.00 to 1000.00
Epidote	2.00 to 10.00
Fire Opal. (See Opal.)	
Garnet	.50 to 12.00
Heliotrope	.50
Hiddenite	15.00 to 75.00
Hyacinth	5.00 to 15.00
Jacinth or Hyacinth. (See Hyacinth.)	
Jade	.50 to 3.00
Jargon	10.00 to 20.00
Kunzite	12.00 to 18.00
Lapis Lazuli	.50 to 1.00
Malachite	.75 to 2.00
Malachite and Azurite	.75 to 2.00
Matrix Turquois, variety. (See Turquois.)	
Mexican Opal, variety. (See Opal, precious.)	
Montana Sapphire, variety. (See Sapphire.)	
Moonstone	.50 to 1.50
Moss Agate	.50
Opal, fire	.25
Opal, precious	2.00 to 25.00
Oriental Amethyst, variety. (See Amethyst.)	
Oriental Emerald, variety. (See Emerald.)	
Oriental Ruby, variety. (See Ruby.)	
Oriental Sapphire, variety. (See Sapphire.)	

	Price per carat.
Oriental Topaz, variety. (See Topaz.)	
Peridot	$4.00 to $15.00
Precious Opal, variety. (See Opal.)	
Quartz, Rose	2.00
Quartz, Smoky	1.50
Rose Quartz, variety. (See Quartz.)	
Ruby, Arizona, variety of Garnet	1.50 to 12.00
Ruby, oriental	25.00 to 1000.00
Ruby Spinel, variety. (See Spinel.)	
Sapphire, oriental	25.00 to 140.00
Sapphire, Montana, blue	3.50 to 40.00
Sapphire, Montana, pink	5.00 to 30.00
Smoky Quartz, variety. (See Quartz.)	
Spinel Ruby	8.00 to 20.00
Sunstone	.50 to 2.00
Thomsonite	.50
Titanite	7.50 to 15.00
Topaz, blue	3.00 to 10.00
Topaz, golden	2.00 to 8.00
Topaz, pink	4.00 to 8.00
Topaz, oriental	5.00 to 30.00
Topaz, white	2.00 to 8.00
Tourmaline, pink	4.00 to 15.00
Tourmaline, green or brown	5.00 to 12.00
Turquois	2.00 to 12.00
Turquois, matrix	.50
Varicite	1.50

VALUES OF METALS AND MINERALS.

All these figures fluctuate, but they will often at least give a prospector some idea as to whether or not a deposit is worth "locating."

METALS.

Aluminum (99%), per pound	$.45 to $.50
Antimony, per pound	.10 to .12
Copper, per pound	.15 to .25
Gold, per ounce	20.00
Lead, per pound	.04 to .06
Magnesium, per pound	6.50 to 7.50
Mercury, per flask of 75 pounds	40.00 to 60.00
Nickel, per pound	.45 to .65
Platinum, per ounce	30.00
Silver, per ounce	.65
Tin, per pound	.35 to .45
Zinc, per pound	.07 to .08

MINERALS.

Barite (ground and floated), per ton	$12.50 to $20.00
Borax, per pound	.06
Bort, per carat	85.00
Calcite (ground), per ton	9.50 to 10.00
Chalk, per ton	3.00
Columbite (40% tantalic acid), per pound	.20
Corundum, per pound	.07 to .10
Emery (ground), per pound	.02 to .05
Feldspar (ground), per ton	9.50 to 10.00
Fluorite (lump), per ton	6.00 to 7.50
Fluorite (ground), per ton	10.00 to 12.50
Graphite, per pound	.01 to .10
Gypsum (lump), per ton	7.00
Gypsum (ground), per ton	12.00 to 20.00
Infusorial Earth, per pound	.02 to .05
Kaolin, per ton	8.00 to 18.00
Magnesite, per ton	7.00 to 8.00

Molybdenite (90%), per ton	\$4.50 to \$5.00
Monazite Sand (95% sand with 5% thorium), per pound	.08 to .10
Muscovite (ground), per ton	20.00 to 30.00
Muscovite (scrap), per ton	40.00 to 75.00
Phosphate Rock, per ton	10.00 to 12.00
Pyrite (non-arsenical), per unit of sulphur .	.10 to .15
Pyrite (arsenical), per unit of sulphur . . .	.12 to .14
Pyrolusite (80%–85% MnO_2) per ton . .	35.00 to 60.00
Quartz (lump), per ton	2.00 to 4.00
Quartz (ground), per ton	10.00 to 15.00
Rutile (90%) per ton	120.00 to 160.00
Salt (lump), per ton	3.00 to 4.50
Talc, per ton	15.00 to 30.00
Tungsten (60% WO_3), per ton	9.00 to 10.00

GLOSSARY.

(With examples.)

Acicular. Needle-like. (Natrolite.)

Adamantine Lustre. The lustre of oiled-glass, exhibited by minerals with a high index of refraction. (Diamond, Cerussite.)

Aggregates. Clusters or groups.

Alkaline Taste. Like soda. (Natron, Borax.)

Amorphous. Without crystalline form or structure, *i.e.*, without a regular arrangement of the molecules. (Opal, Turquois.)

Arborescent. Resembling a tree in appearance. (Native Copper and Silver.)

Astringent Taste. Causing the mouth to "pucker." (Some Boracite.)

Bladed. Decidedly elongated and flattened. (Wollastonite, Cyanite.)

Botryoidal. Globular masses so united as to resemble a bunch of grapes. (Chalcedony, Prehnite.)

Brittle. The quality which causes a substance to break readily when struck with a hammer. (Sulphur, Pyrite.)

Capillary. Hair-like. (Millerite, Mesolite.)

Chatoyant Lustre. Changeable, undulating reflections from beneath the surface. (Moonstone, Crocidolite.)

Cleavage. The property possessed by many crystalline substances which causes them to break more or less easily and smoothly in definite directions, *i.e.*, parallel to possible crystal faces. (Galenite, Calcite.)

The cleavage may be very perfect, perfect, good, fair, or poor depending upon the ease with which it can be developed and the smoothness of the resulting faces.

Cleavage faces may usually be distinguished from crystal faces by the fact that they appear to be covered with thin plates, forming low steps.

Cleavage is said to be cubical, octahedral, dodecahedral, pyramidal, prismatic, pinacoidal and rhombohedral, q. v.

More than one kind of cleavage is often found on one mineral.

Columnar. Column-like forms, usually in nearly parallel position. (Stibnite, Jamesonite.)

Compact. Made up of very fine, closely united particles. (Magnesite, Datolite.)

Conchoidal Fracture. Smoothly curving like the interior of a shell.

The following three kinds of substances may show a conchoidal fracture:

1. Amorphous substances. (Chrysocolla.)
2. Cryptocrystalline or very fine grained. (Chalcocite.)
3. Individual crystals without cleavage. (Quartz.)

Concentric. Showing spherical crusts or layers, one within another. (Arsenic.)

Contact Twin. The simplest type of twin (q. v.), in which two portions of a crystal appear to have been united along a common plane after one portion has been revolved 180° relative to the other. The plane of contact (plane of union or the composition face) may or may not be the twinning plane. (Hornblende, Epidote.)

Cryptocrystalline. ("Hidden crystalline.") Composed of microscopic crystals or crystalline grains, *i.e.*, very fine grained. (Chalcedony, Datolite.)

Crystal. A mineral bounded wholly or partially by natural plane surfaces, called faces.

Crystalline. With a regular molecular arrangement. This is manifested in many ways, such as a definite external form — "crystals" —, the presence of cleavage, or the ability to polarize light. (Orthoclase, Quartz.)

Cubical Cleavage. Equally good cleavage in three directions at angles of 90°. (Galenite, Halite.)

Cylic Twin. Composed of parts which appear to have been alternately revolved 180° upon non-parallel twinning planes. The varieties with names are trillings, fourlings, sixlings and eightlings, q. v.

Decrepitate. Fly to pieces when heated with a blowpipe. (Jamesonite, Halite.)

Deliquescent. Capable of extracting considerable water from the air and thus tending to form a liquid.

Dendritic. Fern-like. (Native Copper, Wad.)

Dichroic. Exhibiting different colors or tints when looked through in different directions. Only seen in transparent minerals. (Epidote, Vivianite.)

Dimorphic. A term applied to a substance which crystallizes in two systems, or in one system with absolutely different unit axial values. (FeS_2, $CaCO_3$.)

Disseminated. Scattered rather uniformly through something. (Precious Metals.)

Dodecahedral Cleavage. Equally good cleavage in six directions at angles of 60°, 90° and 120°. (Sphalerite, Sodalite.)

Druse. A great many very small crystals crowded closely together. (Calamine, Chabazite.)

Ductile. Capable of being drawn into wire. (Copper, Platinum.)

Dull Lustre. Without "shine" of any kind. (Chalk, Hydrozincite.)

Earthy. Earth-like.

Efflorescence. A crust, powder, or crystalline coating formed on the surface by the evaporation of mineralized water. (Borax, Thenardite.)

Eightling. A cyclic twin (q. v.) made up of eight portions. (Rutile.)

Elastic. The property which causes a portion of a substance to resume its original position after it has been displaced. (Capillary Millerite, Muscovite.)

Exfoliate. To swell or puff out when heated with the blowpipe, due to a separation into leaves or folia. (Stilbite, Jefferisite.)

Feldspathoid. A mineral resembling a feldspar in composition but differing in physical characteristics. (Leucite, Sodalite, Nephelite.)

Fetid. Having the odor of H_2S, or bad eggs. (Some Limestone and Barite.)

Fibrous. Composed of fine, slender filaments or fibres. (Asbestus, Crocidolite.)

Filiform. Wire- or thread-like. (Millerite, Mesolite.)

Flexible. Capable of being bent without fracture. (Chlorite, Gypsum.)

Foliae. Same as lamellae, q. v.

Foliated. Leafy or platy. (Micas, Talc.)

Fourling. A cyclic twin (q. v.) made up of four portions. Rare.

Fracture. The manner in which a mineral breaks other than along cleavage or parting planes. Fracture is said to be uneven, hackly, splintery or conchoidal, q. v.

Gangue. The worthless rock or minerals in which a more valuable or interesting mineral is imbedded or to which it is attached.

Granular. Composed of coarse to fine grains. (Pyrrhotite, Emery.)

Globular. Globe-like. (Conichalcite, Wavelite.)

Hackly. Jagged; covered with sharp points. (Native Metals.)

Hardness. The power of resisting abrasion or scratching. See Moh's scale of hardness elsewhere.

Imitative. Resembling some familiar object or form. See acicular, arborescent, botryoidal, dendritic, lenticular, nodular, oolitic, pisolitic, reniform, reticulated, stalactitic, etc.

Incrusted. Covered with a thin layer or crust.

Incrusting. Occurring as a thin layer or crust on something else. (Millerite, Marcasite.)

Interpenetration Twins. A term applied to two or more crystals in twinned (q. v.) position when they penetrate each other, being not merely united by the adherence of external faces. (Carlsbad twins of Orthoclase, Thenardite.)

Intumescence. Boiling when heated with the blowpipe. (Chabazite, Thomsonite.)

Iridescent. Showing a play of prismatic colors. (Many sulphides.)

Isomorphic. Two minerals of different compositions but the same crystallization. (Argentite, Galenite.)

Isomorphic Group. A group of minerals all of which crystallize alike. (Pyrite Group, Calcite Group.)

Lamellar. Same as foliated, q. v.

Lamellae. Thin plates, leaves, or sheets. (Brucite, Micas.)

Laminated. Same as foliated, q. v.

Laminae. Same as lamellae, q. v.

Lenticular. Lens-shaped. (Some Calcite crystals and many nodules, q. v.)

Lustre. The manner in which a substance reflects light. The following different varieties are recognized: adamantine, chatoyant, dull, greasy, metallic, pearly, resinous, silky, stony, q. v.

The intensity of the lustre is indicated by the use of the terms splendent, brilliant, shining, glistening, etc.

The prefix sub is used to indicate an imperfect lustre of the kind specified.

Magnetic. Attracted to the magnet. (Magnetite, Pyrrhotite.)

Malleable. Capable of being hammered into thin sheets. (Gold, Silver.)

Mammillary. Rounded protuberances with the form of flat domes. (Hematite, Aragonite.)

Massive. In masses without definite crystalline form. (Thaumasite, Serpentine.)

Metallic Lustre. The lustre of a metal. (Galenite, Chalcopyrite.)

Micaceous. Composed of small plates or leaves. (Micaceous Hematite, Astrophyllite.)

Mineral. A natural occurring, homogeneous, inorganic substance. (Quartz, Gold.)

Multiple Twin. Composed of parts which appear to have been alternately revolved 180° upon parallel or non-parallel twinning planes. These are of two kinds, *i.e.*, cyclic twins and oscillatory twins, q. v.

Nodular. Completely spherical, ovoid, or disk-shaped; usually imbedded in some other material.

Nodules. Spherical, ovoid, disk-shaped, cylindrical, or imitatively shaped forms which are made by the segregation of some foreign substance disseminated in small amounts through some different material. The segregation often takes place around a nucleus of organic matter.

As used in mineralogy, the term is applied to anything with either of the first three above mentioned shapes, regardless of how it was formed.

Octahedral Cleavage. Equally good cleavage in four directions at angles of about 109° and 71°. (Diamond, Fluorite.)

Oolitic. Composed of small globules like fish eggs. (Oolitic Hematite, Oolitic Calcite.)

Opalescence. A milky or pearly appearance, due to reflection from below the surface. (Opal.)

Opaque. Does not transmit light even on thin edges. (All minerals with a metallic lustre, and many others.)

Oscillatory Twins. Composed of laminae or parts which appear to have been alternately revolved 180° upon parallel twinning planes. (Plagioclases, Calcite.)

Paramorph. A crystal that has undergone a change in its physical properties without a corresponding change in composition. (Calcite to Aragonite, Pyroxene to Hornblende.)

Parting. A separation other than cleavage in a rather definite direction. This may coincide with some crystallographic direction as in the case of parting due to twinning (Calcite, Titanite, Corundum), or it may be in any direction as when produced by pressure.

Parting can be distinguished from cleavage by the fact that it cannot be induced anywhere on a specimen, but will only occur along lines of weakness.

Pearly Lustre. Like mother-of-pearl. (Apophyllite, Muscovite.)

Penetration Twins. Same as interpenetration twins, q. v.

Phenocrystalline. Evidently crystalline. Not necessarily in distinct crystals but the crystalline structure can be readily proven by the presence of cleavage or peculiar optical characteristics. (Rose Quartz, etc.)

Pinacoidal Cleavage. Cleavage in only one direction. (Topaz, Colemanite.)

Pisolitic. Composed of globules between the size of "BB" shot and peas. (Pisolitic Calcite.)

Pleochroic. Exhibiting several different colors or tints when looked through in different directions. See dichroic.

Polarize. A substance is said to polarize light when all the rays that pass through it are forced to vibrate in two planes at right angles to each other. All crystalline substances except those in the isometric system will do this.

Polysynthetic Twins. ("Many unions.") Same as oscillatory twins, q. v.

Primary. Original. A mineral which crystallized when the rock in which it is embedded was formed is said to be primary.

Prismatic. Elongated decidedly in one direction but with sufficiently large dimensions in other directions to prevent it from being called acicular, capillary, or bladed, q. v. (Actinolite, Staurolite.)

Prismatic Cleavage. As usually used, this means equally good cleavage in two directions, the angle varying with the system, and being 90° for tetragonal minerals, only. (Enargite, Wernerite.)

In the case of the hexagonal minerals, the corresponding cleavage should be called hexagonal prismatic, and means equally good cleavage in three directions at angles of 60° and 120°.

Pseudomorph. A substance occurring with the crystalline form of another, due to the alteration or replacement of the second to or by the first. (Martite, Limonite after Pyrite.)

Pyramidal. Resembling a pyramid, *i.e.*, a form bounded by triangular faces which meet in a common point.

Pyramidal Cleavage. As usually used, this means equally good cleavage in four directions at varying angles. Rare.

In the case of the hexagonal minerals the corresponding cleavage should be called hexagonal pyramidal, and means equally good cleavage in six directions at varying angles. Rare.

Reniform. Kidney-shaped. (Some Hematite and Limonite.)

Repeated Twins. Same as multiple twins, q. v.

Reticulated. Showing fibres crossed like a net. (Stibnite, Rutile.)

Resinous Lustre. Resembling resin, or rosin. (Realgar, Sphalerite.)

Rhombohedral Cleavage. Equally good cleavage in three directions at varying angles. (Calcite, Rhodochrosite.)

Rock. Any substance not a liquid which forms a considerable portion of the earth's crust. (Limestone, Phosphate Rock.)

Scaly. Made up of very small leaves or scales. (Some Kaolin.)

Secondary. A mineral whose formation took place after the rock in which it is imbedded was formed is said to be secondary. (Kaolin, Chlorite.)

Sectile. Capable of having little slices or shavings cut from it with a knife. (Orpiment, Argentite.)

Silky Lustre. With a sheen like silk. (Malachite, Pectolite.)

Sixling. A cyclic twin (q. v.) made up of six portions. (Aragonite, Witherite.)

Spar. A name given by miners to almost any cleavable mineral with a vitreous lustre. (Fluor-spar, Heavy-spar.)

Specific Gravity (S. G.). This equals the quotient obtained by dividing the weight of a substance by the weight of an equal volume of water at 15° C. The result shows how many times heavier or lighter than water the substance tested is.

The average S. G. of the materials of the earth's crust

is about 2.5; anything above this figure is regarded as heavy and anything under this will seem light.

Splintery Fracture. Breaking into long slivers or splinters. Rare.

Stalactitic. Resembling an icicle. (Calcite, Aragonite.)

Stellate. Star-like. (Strontianite and Cerussite twins.)

Stony Lustre. The lustre of weathered rocks. (Orthoclase, Spodumene.)

Streak. The color of the powdered mineral. It is usually obtained by rubbing the mineral upon a piece of unglazed porcelain, called a streak plate.

If the lustre is metallic, the streak will usually be as dark or darker in color than is the mineral itself. If the lustre is not metallic, the opposite is usually true.

Striated. Covered with striations, q. v.

Striations. Very distinct, parallel lines which are really a succession of very minute ridges and furrows or very low steps. They may be produced in the following two ways:

1. By the oscillation or alternate appearance of different crystal faces, thus forming a series of low steps. Striations of this character are confined to the surface of crystals. (Pyrite, Garnet.)
2. By oscillatory or repeated twinning. Striations thus produced are to be seen on cleavage, as well as crystal, faces. (Plagioclases, Corundum.)
Sometimes striation-like lines are produced by cleavage or other causes, but these are disregarded.

Sulpho Salt. A compound containing one or more bases combined with Sulphur and a semi-metal, the latter being united in a definite ratio.

Tabular. Tablet-shaped. (Barite, Wulfenite.)

Tarnish. A very thin coating formed on many minerals by slight changes in composition induced by exposure to the atmosphere. (Arsenic, Bornite.)

Termination. The group of faces enclosing the end of an elongated crystal.

Titano-silicate. A compound composed of one or more bases united to both titanic and silicic acids.

Tough. Not easily broken with a hammer. (Mountain Cork, Sepiolite.)

Transparent. Objects can be seen through the substance. (Rock Crystal, Iceland Spar.)

Translucent. Objects cannot be seen through the substance but light is transmitted through the same. (Orpiment, Crocoite.)

Trilling. A cyclic twin made up of three portions. Rare.

Twin. Two or more crystals or portions of one crystal so united that, if alternate crystals or portions could be revolved 180° on so-called twinning planes, one simple untwinned crystal would be formed.

The twinning planes cannot be parallel to symmetry planes and must be parallel to possible crystal faces.

Three classes of twins are recognized, *i.e.*, contact twins, interpenetration twins and multiple twins, q. v.

Uneven Fracture. Rough fracture. (Tetrahedrite, Milky Quartz.)

Vitreous Lustre. The lustre of glass. (Topaz, Tourmaline.)

TABLE OF ELEMENTS WITH THEIR SYMBOLS AND ATOMIC WEIGHTS.

Name.	Symbol.	At. Wts.	Name.	Symbol.	At. Wts.
Aluminum	Al	27.1	Neodymium	Nd	143.6
Antimony	Sb	120.2	Neon	Ne	20.
Argon	A	39.9	Nickel	Ni	58.7
Arsenic	As	75.	Nitrogen	N	14.04
Barium	Ba	137.4	Osmium	Os	191.
Bismuth	Bi	208.5	Oxygen	O	16.
Boron	B	11.	Palladium	Pd	106.5
Bromine	Br	79.96	Phosphorus	P	31.
Cadmium	Cd	112.4	Platinum	Pt	194.8
Caesium	Cs	132.9	Potassium	K	39.15
Calcium	Ca	40.1	Praseodymium	Pr	140.5
Carbon	C	12.	Radium	Ra	225.
Cerium	Ce	140.25	Rhodium	Rh	103.
Chlorine	Cl	35.45	Rubidium	Rb	85.4
Chromium	Cr	52.1	Ruthenium	Ru	101.7
Cobalt	Co	59.	Samarium	Sm	150.
Columbium	Cb	94.	Scandium	Sc	44.1
Copper	Cu	63.6	Selenium	Se	79.2
Erbium	Er	166.	Silicon	Si	28.4
Fluorine	F	19.	Silver	Ag	107.93
Gadolinium	Gd	156.	Sodium	Na	23.05
Gallium	Ga	70.	Strontium	Sr	87.6
Germanium	Ge	72.5	Sulphur	S	32.06
Glucinum*	Gl	9.1	Tantalum	Ta	183.
Gold	Au	197.2	Tellurium	Te	127.6
Helium	He	4.	Terbium	Tb	160.
Hydrogen	H	1.008	Thallium	Tl	204.1
Indium	In	114.	Thorium	Th	232.5
Iodine	I	126.85	Thulium	Tm	171.
Iridium	Ir	193.	Tin	Sn	119.
Iron	Fe	55.9	Titanium	Ti	48.1
Krypton	Kr	81.8	Tungsten	W	184.
Lanthanum	La	138.9	Uranium	U	238.5
Lead	Pb	206.9	Vanadium	V	51.2
Lithium	Li	7.03	Xenon	Xe	128.
Magnesium	Mg	24.36	Ytterbium	Yb	173.
Manganese	Mn	55.	Yttrium	Yt	89.
Mercury	Hg	200.	Zinc	Zn	65.4
Molybdenum	Mo	96.	Zirconium	Zr	90.6

* Glucinum (Gl) is the same as Beryllium (Be).

MOH'S SCALE OF HARDNESS.

The hardness of minerals is most accurately determined by comparison with minerals of known hardness. In making this test, it is important to remember that if one mineral will scratch another, the former has a hardness equal to, or greater than, that of the latter.

Moh suggested that ten more or less common minerals should be used as a scale of hardness, and the species he selected are given below. The units on this scale are not equally spaced — the difference between hardnesses 9 and 10 being as great as the difference between hardnesses 1 and 9 — but the inequalities are not great enough to cause trouble.

Hardness

1. *Talc* (foliated, light green).
2. *Gypsum* (Selenite) or Halite.
3. *Calcite* (transparent).
4. *Fluorite* (transparent).
5. *Apatite* (transparent).
6. *Orthoclase* (good vitreous lustre).
7. *Quartz* (transparent).
8. *Topaz* (transparent).
9. *Corundum* (cleavable).
10. *Diamond.*

If specimens of the above minerals are not at hand, the hardness of all but the hardest minerals can be approximately determined by applying the following facts:

The finger nails will scratch minerals with a hardness equal to, or less than, 2½.

A copper coin will just scratch a mineral of hardness 4.

A good knife will scratch minerals with a hardness of 5½.

Glass is scratched by minerals over 6 in hardness.

VON KOBELL'S SCALE OF FUSIBILITY.

The fusibility of a mineral can best be tested by placing a fine splinter — held in platinum forceps — in the hottest part of the blow-pipe flame. Six degrees of fusibility can then be recognized, as shown by the following table:

Degree

1. *Stibnite.* Coarse splinters fuse very easily.
2. *Natrolite.* Coarse fragments fuse easily.
3. *Almandite Garnet.* Fine fragments fuse easily.
4. *Actinolite.* Fine fragments fuse fairly easily.
5. *Orthoclase.* Fine fragments fuse with great difficulty.
6. *Bronzite or Calamine.* Practically infusible, only the thinnest edges being slightly rounded.

INDEX.

NOTE: Names of mineral species are in heavy-face type, synonyms are in light-face type, and the names of varieties of mineral species are in *italics*.

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